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INTERNATIONAL CONCILIATION

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THE INTERNATIONAL GEOPHYSICAL YEAR

The International Geophysical Year was "the single most significant peaceful activity of mankind since the Renaissance and the Copernican Revolution." This summation by Dr. Hugh Odishaw, Executive Director of the United States National Committee for the IGY, voiced the enthusiasm felt by scientists the world over for the vast enterprise in which some 30,000 of them participated in thousands of scientific stations from pole to pole. The IGY, said Dr. Odishaw, was not a government program, despite government support; it was not a military program, despite invaluable logistical support from the armed services; and it was not an "internationalized program," despite the close collaboration of nationals from 66 countries—each country carried out its own program coordinated by a small core of unpaid officials. For the scientists in the IGY, bureaucracy was a delightfully unfamiliar word.

In the following pages, the story of the IGY from the point of view of the social historian is told for the first time. With the one major exception of China, it is the story of the triumph of science over politics, in the vast reaches of the Antarctic, beneath the earth's crust, and up into outer space.

WALTER SULLIVAN, the author of this issue, is exceptionally qualified for his task. From the earliest inception of the IGY through to the end, he covered it for *The New York Times,* the only general publication to assign a full-time reporter to the Year. He has viewed the IGY both in depth and breadth to a rare and perhaps unique degree. Before the IGY began, Mr. Sullivan had already won his spurs on three Antarctic expeditions. His book, *Quest for a Continent,* has appeared in English, German, and Japanese.

ANNE WINSLOW
Editor-in-Chief

January 1959

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Prelude

IT HAS BEEN SAID by an eminent historian that there has been no event in history since the rise of Christianity to compare with the "scientific revolution" in its influence on the course of humanity.[1] In the sixteenth and seventeenth centuries, modern science overthrew the old habits of thought; in the twentieth century, its achievements have become spectacular. It is not unlikely that the year 1957 will be as familiar to school children 1,000 years from now as the year 1492 is today, for it opened the door to outer space.

Although this was first achieved by a Soviet intercontinental ballistic missile, it is also significant that the door was opened under international auspices. The satellite-launchings of both the United States and Soviet Union were part of the agreed program of the International Geophysical Year (IGY). This cooperative effort by 66 nations,[2] including all major countries of the world except the People's Republic of China, could prove, from the perspective of the future, to have been a turning point in the history of mankind—the start of a period in which scientists assumed a greater role in helping to solve international problems.

In 1945, many hoped that science had brought permanent peace by producing a weapon so destructive that future wars

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[1]Herbert Butterfield, *The Origins of Modern Science* (London, G. Bell, 1949), p. viii.

[2]Argentina, Australia, Austria, Belgium, Bolivia, Brazil, Bulgaria, Burma, Canada, Ceylon, Chile, Republic of China, Colombia, Cuba, Czechoslovakia, Denmark, Dominican Republic, East Africa, Ecuador, Egypt, Ethiopia, Finland, France, German Democratic Republic, German Federal Republic, Ghana, Greece, Guatemala, Hungary, Iceland, India, Indonesia, Iran, Ireland, Israel, Italy, Japan, Democratic People's Republic of Korea, Malaya, Mexico, Mongolian People's Republic, Morocco, Netherlands, New Zealand, Norway, Pakistan, Panama, Peru, Philippines, Poland, Portugal, Rhodesia and Nyasaland, Romania, Spain, Sweden, Switzerland, Tunisia, Union of South Africa, USSR, United Kingdom, United States, Uruguay, Venezuela, Democratic Republic of Viet Nam, Republic of Viet Nam, Yugoslavia.

would be unthinkable. This proved overly optimistic. But science may still be able to provide mankind with sufficient abundance, good health, and security to moderate a primary impetus to war. It may, in addition, provide a meeting ground where East and West can find mutually acceptable techniques for disarmament.

The IGY has been an eighteen-month "year" of study in those sciences dependent upon coordinated observations at many points. Its length was determined by the extent of the programs planned and by a desire to span completely the predicted period of maximum sunspots. Although the most publicized aspect of the IGY was its space-satellite program, the studies extended from the sun to submarine canyons almost seven miles below the ocean waves. The leaders of the IGY sought to keep it aloof from political rivalries. They were largely successful, but as the program developed this task proved more difficult than anticipated.

Forerunners of the IGY

International science can be traced back to the ancients, who exchanged data in order to construct maps needed for their mutual benefit. It developed further as man gazed into space and sought to measure celestial distances.

Nevertheless, it was not until the last century that synoptic observations—made simultaneously by many men at many points—became general. In France, during the first fifteen years of the nineteenth century, the Chevalier de Lamarck, with Pierre Laplace, Antoine Lavoisier, and others, began the first international compilation of weather information. This was soon followed by the construction of weather maps, which in their day were examples of pure science rather than practical research, for they were of no use in weather forecasting. Without radio, telephone, or telegraph it took weeks to assemble the data. Yet when weather maps for successive days were studied, the patterns of storm formation and movement became apparent for the first time. The modern science of meteorology was born.

While weather studies were being advanced in France, two great German scientists applied the same technique to the magnetism that controls the compass needle. Baron Alexander von Humboldt had noted that the direction and intensity of this force varied from day to day at any one locality and wished to see if these variations fitted into a world pattern. At a scientific congress in Berlin in 1828, he proposed a scheme of widespread observations. In the years that followed, he persuaded the Russians to establish a chain of magnetic observatories across Russia and Siberia to Alaska. The Royal Society of Britain agreed to do likewise throughout the British Empire, and United States scientists also said they would cooperate.

Meanwhile, Baron von Humboldt's friend, Karl Friedrich Gauss, had founded, with his co-worker Wilhelm Weber, the Magnetischer Verein (Magnetic Union) with headquarters in Göttingen. It soon grew from a German affair into an international organization that fixed, long in advance, special days for simultaneous recording of the earth's magnetism. Between 1835 and 1839 observations were carried out from the Netherlands to Sicily. Such was the impact of this work on the scientific world that, during the years that followed, many observatories kept their clocks on Göttingen time to facilitate later comparison of the recorded data. The results of their efforts disclosed to Herr Gauss and Baron von Humboldt some of the fundamentals of geomagnetism. The latter identified "magnetic storms" involving the entire magnetic field of the earth; Herr Gauss devised a theory to correlate the direction and strength of magnetic force with the location on earth. Baron von Humboldt's efforts led to "that scientific conspiracy of nations which is one of the noblest fruits of modern civilization."[3]

One of Baron von Humboldt's friends and admirers was a United States naval officer who had been crippled when a stagecoach overturned. Matthew Fontaine Maury, forced by

[3]Agnes Mary Clarke, *Encyclopaedia Britannica,* Vol. 13 (New York, Encyclopaedia Britannica, Inc., 1919), p. 874.

his disability to remain ashore, presided over the birth of the United States Naval Observatory and the Navy's Hydrographic Office. As early as 1851, he proposed a plan for coordinated, world-wide weather observations, both at sea and ashore. Reportedly on the advice of British scientific friends, he limited his initial effort to ship-based observations and obtained authority from the Secretary of the Navy to approach the embassies in Washington with his scheme.

As a result, in 1853, an international conference was held in Brussels to discuss Commander Maury's plan. Represented were Belgium, Britain, Denmark, France, the Netherlands, Norway, Portugal, Russia, Sweden, and the United States. It was agreed that the warships of these nations would use standard forms to record weather and oceanic phenomena wherever they went, pooling the information for the good of mankind. The records were to be sacrosanct, even when such ships were captured in time of war.

> Rarely before [Commander Maury wrote] has there been such a sublime spectacle presented to the scientific world: all nations agreeing to unite and coöperate in carrying out one system of philosophical research with regard to the sea. Though they may be enemies in all else, here they are to be friends.[4]

The Commander then proposed a second conference to map a program of international weather observations on land. The Crimean War (1853-55) helped to doom this proposal, and his subsequent effort to organize a nation-wide weather service in the United States, to take advantage of the fast-developing telegraph nets, likewise failed.

During the latter half of the nineteenth century, international science advanced by leaps and bounds. In France, a century earlier, Alexis Claude Clairault had presented a theorem that fixed the equatorial bulge of the earth in terms of the competing tugs of gravity and centrifugal force. In part to test his formulae by far-flung surveys and astronomical observations, the International Association of Geodesy

[4]M. F. Maury, *Physical Geography of the Sea* (1855), p. xiii.

was formed in 1864. It became what is regarded as the first long-lived international organization of scientists, but it was soon apparent that such work required standardization of measurements, and hence the International Bureau of Weights and Measures was formed in 1875.

In that same year Karl Weyprecht, a lieutenant in the Austrian Navy who had distinguished himself in Arctic exploration, presented to the German Scientific and Medical Association meeting in Graz a paper that set in motion the First Polar Year[5]—grandfather of the IGY. This was an era of extensive polar exploration. Lieutenant Weyprecht argued that on such expeditions the quest for scientific knowledge, rather than the sighting of new capes and bays, should be given priority. He proposed the establishment of two rings of stations as close as possible to the Arctic and Antarctic Circles, respectively, to take synchronized observations of weather, the earth's magnetic field, and so forth. His ideas were warmly received. Chancellor Bismarck appointed a commission of leading scientists to study the plan, and they commended it to the Bundesrat, urging, however, that other nations join to ensure a successful program.

The plan was endorsed in Rome in April 1879 by the International Meteorological Congress, which stressed the need for wide international participation. The Congress called an International Polar Conference to meet in Hamburg the following October. Eight countries were represented, and Dr. Georg von Neumayer, who had followed in Baron von Humboldt's footsteps as a scientific traveller, was elected president of the meeting. A dozen stations were allocated—eight in the Arctic and four in the Antarctic.

In August 1880, a conference was held in Berne, Switzerland, to work out further details. Dr. Heinrich von Wild presided and was made president of the International Polar Commission, which ran the program. It was decided that the coordinated observations would run for one year, begin-

[5]The First Polar Year is also known as the First International Polar Year. To its contemporaries it was known by such titles as the Polar Year or the International Circumpolar Stations.

ning in August 1882, with fourteen stations.[6] Previously established observatories in temperate latitudes joined in making simultaneous observations, so that about 40 stations in all took part. They included observatories in Los Angeles, Peking, Shanghai, and five points in what is now the USSR.

The ship in which the Dutch sought to reach the Yenisei River in northwestern Siberia was crushed by the ice, but the men were saved. The American expedition, led to Ellesmere Island by Captain Adolphus W. Greely, United States Army, was less fortunate. For two successive years relief ships failed to reach his party, and when it was found, the third year, only seven of the original 24 men were still alive; they had survived by eating their shoes and furs.

> The work of the International Polar Commission [Captain Greely wrote] will live in history as a great one, if only as an epoch in modern civilization marked by the union of eleven great nations in planning and executing for strictly scientific purposes so extensive and dangerous a work.[7]

One of the more memorable fruits of the First Polar Year was the study by Herman Fritz of the aurora, or "northern lights," which led to the first orderly picture of auroral distribution. It was found that on virtually every cloudless night the curtains of light were visible in a band circling the North Geomagnetic Pole at a distance of about 1,500 miles.

The success of this Year led to the larger effort of the Second Polar Year, which began 1 August 1932, just 50 years to the day after its predecessor. Like the earlier program, it was organized under the auspices of international scientific bodies that were forerunners of the World Meteorological Organization. Again the emphasis was on weather, the earth's

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[6] *Arctic*: Jan Mayen, Norwegian Sea (Austria); Great Slave Lake, Canada (Britain); Godthaab, Greenland (Denmark); Sodankyla, Finland (Finland); Cumberland Sound, Baffin Island (Germany); Mouth of the Yenisei River, Siberia (Netherlands); Alten Fiord, Norway (Norway); Mouth of the Lena River, Siberia, and Novaya Zemlya (Russia); Spitsbergen (Sweden); Point Barrow, Alaska, and Lady Franklin Bay, Ellesmere Island (United States). *Antarctic*: Cape Horn (France); South Georgia (Germany).

[7] A. W. Greely, *Three Years of Arctic Service*, Vol. 1 (New York, Scribner, 1886), p. 24.

magnetism, and the aurora. There were also studies of earth-sun relationships and of atmospheric electricity. The program was far more extensive than that of a half century earlier and, though much narrower in scope than the IGY, it displayed many of the features of its offspring. Unfortunately, the program coincided with a period of world-wide economic distress and hence was severely curtailed.

As with the IGY, the task of organizing devolved largely on national committees in each of some 33 participating nations. Their work was coordinated by an international commission headed by Dr. D. LaCour of Denmark. An estimated 250 scientists were employed in making observations at 110 stations, half of which were in the polar regions; the rest were distributed between temperate and equatorial latitudes. In addition to all the major western European states, such countries as Brazil, Japan, and the Soviet Union took part. It has been estimated that the knowledge gained during the Second Polar Year as applied to radio communications alone, was worth hundreds of millions of dollars.[8]

Much of the success of the Second Polar Year was made possible by new techniques of observation. Radio equipment had been devised that sent probing signals aloft to determine changes in the height at which radio waves of various frequencies were reflected from the upper, ionized layers of the atmosphere. The value of free-rising balloons to study winds high in the sky was augmented by an experimental balloon-lifted device which radioed weather information back to earth—the birth of the telemetering technique that played a vital role in the IGY. Other work that anticipated similar, but far more extensive, efforts in the IGY included: photography of the aurora at many points to trace the extent of the displays; attempts to learn if the top of the atmosphere is stagnant or windy; and the measurement of the electric currents in the crust of the earth that form part of the complex electro-magnetic system involving earth, sky, and sun.

[8]See, for instance, Dr. Joseph Kaplan, "The International Geophysical Year," an address at Wilson College, Chambersburg, Pa., 25 Oct. 1955. Issued textually by the National Academy of Sciences (mimeo.), p. 1.

Meanwhile, the apparatus of international science had continued to expand. By the end of the nineteenth century the number of international scientific societies had grown to such proportions that, on the initiative of the Göttingen Academy of Sciences, the International Association of Academies was formed in 1900. The pre-eminent role of Germany in the world of science was evident in the Association, which is said to have been dominated by the academies of Berlin, Göttingen, Heidelberg, Leipzig, Munich, and also Vienna.

The organization perished in the ruins of World War I and, in 1919, a new body emerged—the International Research Council—from which Germany was specifically excluded. The initiative for its founding came from the National Academy of Sciences in Washington, the Royal Society of London, and the Académie des Sciences in Paris. It survived for twelve years, when it was replaced by the International Council of Scientific Unions (ICSU).

The short life of the International Research Council has been attributed to two factors. First, by excluding Germany, it permitted political considerations to be injected into science. Second, its statutes provided that it should "initiate" and "direct" various international scientific programs. This led to resentment by the international unions formed under the Council by scientists in various fields, who are said to have felt that there was "an excessive control by the Council of their own affairs."[9]

The organization of ICSU was designed to avert such criticism. Federated within it are thirteen unions, divided into two categories with respect to voting power and representation. Their acronyms, in some cases based on the French titles, are well known in the scientific world, but were clearly not chosen for their euphony:

GENERAL UNIONS

International Astronomical Union (IAU)
International Union of Geodesy and Geophysics (IUGG)
International Union of Pure and Applied Chemistry (IUPAC)

[9]ICSU, *A Brief Outline* (The Hague, ICSU Secretariat, 1958), p. 4.

International Union of Pure and Applied Physics (IUPAP)
International Union of Biological Sciences (IUBS)
International Mathematical Union (IMU)

SPECIALIZED UNIONS

International Scientific Radio Union (URSI)
International Geographical Union (IGU)
International Union of Crystallography (IUCr)
International Union of Theoretical and Applied Mechanics (IUTAM)
International Union of History and Philosophy of Science (IUHPS)
International Union of Physiological Sciences (IUPS)
International Union of Biochemistry (IUB)

National academies of science or comparable bodies representing 45 nations also participate.

Although some of these academies are governmental or quasi-governmental, ICSU is essentially a non-governmental body. The formation, after World War II, of UNESCO provided a parallel organ at the inter-governmental level. A formal agreement was made between the two organizations in 1947 to define their areas of operation. Since then UNESCO has given ICSU about $180,000 a year to aid the latter's program of conferences, publications, and permanent services. And ICSU offers specialized advice when asked by UNESCO.

This brings us to the birth year of the IGY. By 1950 the geophysical sciences—those concerned with the earth and its environment—had reached a point where it was felt that further progress was being hampered by lack of the kind of data obtainable only by a world-wide joint effort. Since the Second Polar Year there had been an almost explosive development of new research tools in this area: radiosonde balloons now brought nine-tenths of the atmosphere, by mass, within range of ordinary weather stations. Not only did the radiosondes send down data from aloft, but their wanderings could now be followed by radar, making possible the automatic recording of winds up to 20 miles overhead. Rockets, produced during the war, had begun to lift the instruments of science above the atmosphere, making possible the first

glimpses into space without the distorting influence of the ocean of air that lies overhead.

New cosmic ray recorders enabled scientists to observe the direction, intensity, and composition of these extremely high energy particles. New types of spectroscopes revealed the changing composition of the aurora—a question of interest to the chemist as well as the geophysicist, since it might provide new information about the properties of hydrogen, oxygen, and nitrogen. Furthermore, it had been discovered that strange patches of light, invisible to the unaided eye, move across the heavens at night—the so-called air glow. The new instruments offered hope for discovering the nature of these lights. A complete array of devices was now on hand with which to examine the sun or to blank out its brilliance so that the glowing corona that surrounds it could be studied. (Some of the solar activity producing a response on earth may take place in this corona.)

By the same token these instruments had raised new and exciting problems for scientists: comparison of magnetic records on moving rolls of paper at stations throughout the world had disclosed a feature known as a Sudden Commencement—a marked change in the magnetic field that occurs at the same instant the world over.

Finally, the development of electronic computers and business machines made it possible to digest the vast amount of data that would result from a world-wide research effort in all the geophysical sciences.

The IGY offered the means to obtain a world picture. The environment with which man has direct contact is no higher, or deeper, than a heavy coat of paint over a schoolroom globe. Our deepest penetration into the crust of the earth, an oil well that goes down somewhat more than four miles, is but a pinprick into that paint; and the 20-mile thickness of the main part of the atmosphere—99 per cent of it, by weight—is merely an extra coating over our heads. The tools available at the start of the IGY made it possible, for the first time, for man to escape from this environment and look directly into naked space.

Preparation

On 5 April 1950, Dr. James A. Van Allen invited a group of United States scientists concerned with upper-air research for an evening of talk with a visitor who has been called the world's most distinguished geophysicist—Dr. Sydney Chapman, then Sedleian Professor of Natural Philosophy at Queen's College, Oxford. Among the guests was Lloyd V. Berkner, a well-known leader in radio-science research, who then headed the Section on Exploratory Geophysics of the Atmosphere, in the Department of Terrestrial Magnetism of the Carnegie Institution of Washington. In the postwar years, Dr. Van Allen had helped the United States to inaugurate space exploration with the firing into the skies over White Sands, New Mexico, of instrument-bearing V-2 rockets captured from the Germans. In 1950, at the age of 35, he headed the high-altitude research program at the Applied Physics Laboratory of Johns Hopkins University.

That evening, during the discussion in the living room of Dr. Van Allen's house at Silver Spring, Maryland, Dr. Berkner proposed a new "polar year," and it was agreed that he would present such a plan at the meeting of the Mixed Commission on the Ionosphere (MCI),[10] to be held three months later in Brussels. The MCI meeting then decided to commend the idea to the three unions with which it was associated and to ICSU itself. It was noted that the period from 1957 to 1958 would fall just 25 years after the Second Polar Year and would coincide with an expected peak of sunspot activity. The Second Polar Year, in contrast, had come at the low point of the eleven-year sunspot cycle. Likewise, 1957-58 was to be marked by several eclipses.

[10] MCI is one of several such bodies within ICSU designed to bring together men from various of the unions concerned with a specialized, overlapping area of research.

MCI's three sponsoring unions backed the plan: the Scientific Radio Union (URSI) at its General Assembly in September, the Astronomical Union (IAU) in an Executive Committee meeting the same month, and the General Assembly of the Union of Geodesy and Geophysics (IUGG) in August 1951. Meanwhile, the ICSU Bureau, the eight-man executive body which runs that organization, commended the proposal in January 1951 to the ICSU Executive Board representing all the unions. The latter, meeting in Washington in October, decided to create a "Special Committee" to work on plans for what was still being referred to as "the Third (International) Polar Year."

In London on 16 May 1952, the ICSU Bureau named Colonel E. Herbays, General Secretary of URSI, as convenor of the new committee; its initial members, nominated by their respective unions were: URSI—Lloyd V. Berkner (United States), W. G. J. Beynon (United Kingdom), alternate; IAU—N. E. Norlund (Denmark), Marcel Nicolet (Belgium), alternate; IUGG—Jean Coulomb (France), V. Laursen (Denmark), alternate; IGU—J. M. Wordie (United Kingdom).

The ICSU Bureau also issued an invitation to nations adhering to ICSU to join the effort. The Soviet Union was not, at that time, a member, but the success of any program would obviously depend heavily on Soviet cooperation in order to obtain data not only from the vast reaches of the USSR but also from other Communist countries, particularly China. Hence a separate invitation was sent to the Soviet Academy of Sciences. Despite its non-adherence to ICSU, the Soviet Union belonged to an ICSU union, IAU, and independent approaches were made through that organization and the World Meteorological Organization (WMO), to which the Soviet Union also belonged. It was urged that the USSR renew the cooperation that marked its participation in the first two polar years and that it encourage other nations to join.

WMO, whose membership includes virtually all nations of the world, was invited to take part in planning the "Year."

WMO felt the program proposed by URSI placed too much emphasis on the polar regions. This view was shared by the International Meteorological Association and the International Association of Terrestrial Magnetism and Electricity, which thought the studies should be world-wide.

Hence Dr. Chapman proposed that the name be changed to International Geophysical Year, and this was approved at the ICSU General Assembly at Amsterdam in October 1952, which endorsed the inclusion of WMO in the Special Committee. The Committee met during that month and sent a follow-up notice to the ICSU countries urging them to form national committees for the IGY. It was also suggested that the national membership of ICSU be expanded, in view of the grand scope of the IGY plan.

The Special Committee, somewhat enlarged, met in Brussels from 30 June to 3 July 1953. It continued to represent scientific unions, rather than national groups, but a dozen observers from nine nations also attended. Dr. Chapman was elected president of the Committee, Dr. Berkner, vice-president, and Dr. Nicolet, secretary-general. Known as the Comité Spécial de l'Année Géophysique Internationale, or CSAGI, this group was to run the IGY. Dr. Nicolet was an authority on the chemistry of the upper air and head of the Radiation Department of Belgium's Royal Meteorological Institute. His office in the Brussels suburb of Uccle became world headquarters of the program.

Growing Participation

By the time of the CSAGI meeting in Brussels, more than a year after ICSU issued its first call, 22 nations had formed IGY national committees, including all the major Western countries, Czechoslovakia,[11] and Yugoslavia. The independence of the Czechs in this respect is of interest, since it was another fifteen months before the Soviet Union led the rest

[11] Czechoslovakia formed a national committee after about 50 of that country's scientists had discussed the question at a meeting during the last week of April 1953.

of its allies into the IGY. Presumably this was because both the Czechs and Yugoslavs were members of URSI, one of the most active IGY sponsors.

May 1954 was set as the deadline for the submission of detailed national programs for dispatch of expeditions and for observation. It was expected that this schedule would make it possible to issue a volume containing the world program for the IGY in order to facilitate advance planning.

Although proceedings of the National Security Council in Washington are traditionally secret, it was understood that that body early decided the United States should make a major effort during the IGY, including a large-scale expeditionary program in Antarctica. Planning and direction of the scientific work was placed under the National Academy of Sciences-National Research Council, and the Department of Defense was told to furnish whatever support was necessary to place the scientists and their instruments in remote locations. Within the Academy, Dr. Joseph Kaplan, a specialist in upper-air research at the University of California at Los Angeles, was made chairman of the United States National Committee for the IGY. The function of the Committee was to make policy. The actual organization of the program was carried out by Hugh Odishaw, the Committee's executive director, with headquarters in Washington.

By March 1954, the United States had outlined a massive program, based on suggestions from several hundred scientists in government agencies, universities, foundations, and private research institutions. Notably advanced, at this early stage, were plans for rocket exploration of the upper air. The program at that time called for 36 Aerobee shots and 37 launchings of rockoons. The latter are lifted high by balloon before being fired.

At this point, although the Soviet Union had not yet responded, many of the decisions that were to shape the IGY had already been made. A program of World Days and periodic ten-day Meteorological Intervals had been worked out by early 1954. The World Days were to occur at a rate of three per month to provide for intensive observation in

many related sciences. During the following summer, there were meetings of URSI, IUPAP, IUGG, WMO, and MCI to develop coordinated plans for presentation to the plenary CSAGI meeting in Rome, from 30 September to 4 October.

By the time of the Rome session, 36 national committees had been formed and IGY plans were well advanced. Then, at the opening of this assembly, the Soviet Embassy in Rome notified CSAGI that the Soviet Academy of Sciences would participate. Joseph Stalin had died nineteen months earlier, and since then Soviet scientists had begun to venture more boldly into the arena of international scientific endeavor. They had been invited to attend the IUGG Assembly held in Rome immediately before the CSAGI meeting, and had accepted. During the following year they formally joined both IUGG and ICSU.

Dr. Vladimir V. Beloussov, a geologist who had led the Soviet scientists at the IUGG Assembly, was chief delegate at the CSAGI meeting. Dr. Chapman welcomed the Russians and, at the end of the conference, gave Dr. Beloussov a chance to speak. The latter proposed that countries of vast area, such as China, India, and the Soviet Union, be included in CSAGI. Dr. Chapman replied that, from the start, it had been hoped that the USSR would take part and that its nationals could serve in the central planning group as representatives of one or both of the participating unions to which Moscow adhered (IAU and WMO). However, efforts by IAU and WMO to achieve this had heretofore proved fruitless. He added that it might still be possible to include Soviet nationals in CSAGI, but noted that its membership consisted of representatives from scientific unions—not national groups.

Ultimately two Soviet nationals were taken into CSAGI. Dr. Beloussov and Dr. N. V. Pushkov, a noted geomagnetist, were included as representatives of IUGG. One of the areas in which Soviet views were already reflected, despite the lateness of Moscow's adherence, was in the weather studies: Dr. A. A. Solotoukhine of the USSR, a member of the WMO Executive Committee, had presented a series of proposals

that had been endorsed by WMO at the IUGG Assembly that preceded the CSAGI meeting.

Basic Policies

In a sense, the IGY was a scientific club. To gain admittance—that is, to be included in the IGY program—a scientific project had to be concerned with "specific planetary problems of the earth." The latter were defined by the Rome conference of CSAGI as follows:

a) Problems requiring concurrent synoptic observations at many points involving co-operative observations by many stations.

b) Problems of branches of the geophysical sciences whose solutions will be aided by the availability of synoptic or other concentrated work during the International Geophysical Year in other geophysical sciences.

c) Observation of all major geophysical phenomena in relatively inaccessible regions of the Earth that can be occupied during the International Geophysical Year because of the extraordinary effort during that interval, in order to augment our basic knowledge of the Earth and the solar and other influences acting upon it.

d) Epochal observations of slowly varying terrestrial phenomena; to establish basic information for subsequent comparison at later epochs.[12]

Where choice was necessary, priority was to be given to programs in category (a), that is, those dependent upon simultaneous, coordinated observations at many points.

The Rome conference also set in motion twin efforts to explore the two great regions which mid-twentieth century technology had brought within the reach of man: the Antarctic and outer space.

The Antarctic effort was, as stated in the conference report, to be "the first really thorough world effort to uncover the geophysical secrets of this great continent." Justification for a concentrated assault there was set forth as follows:

The conduct of geophysical research in Antarctica is significant for many reasons. Antarctica, one of the earth's continents, rep-

[12] CSAGI, *Bulletin d'Information*, No. 4 (IUGG News Letter No. 9, London, 1955), pp. 54-5.

resents a major land mass with an area of about 6,000,000 square miles. It lies almost entirely within the Antarctic Circle (67°S), and by virtue of its unique position and its physical characteristics represents a region of almost unparalleled interest to the fields of geophysics and geography alike. In geophysics, Antarctica has many significant, unexplored aspects: for example, the influence of this huge ice mass on global weather; the influence of the ice mass on atmospheric and oceanographic dynamics; the nature and extent of aurora australis, for, although the aurora borealis has received considerable attention in recent years, the detailed characteristics of Antarctic aurora remain largely unknown; the possibility of conducting original ionospheric experiments northward from the South Polar Plateau during the long total-night season to determine the physical characteristics of the ionosphere during prolonged absence of sunlight. These and similar scientific considerations lead the CSAGI to recognize that Antarctica represents a most significant portion of the earth for intensive study during the International Geophysical Year.[13]

Five other regions were also singled out for special attention: the Arctic, the equatorial region, and three pole-to-pole meridians along which a maximum number of observations were to be made. The latter were designed to obtain complete north-south profiles of such phenomena as air circulation, the electrified layers of air above the weather, and the earth's magnetic field still farther out in space. The north-south zones were chosen to take maximum advantage of existing observatories: 70° to 80° West (east coast of North America, west coast of South America), 10° East (Europe and West Africa), and 140° East (Siberia, Japan, Australia).

The second major objective was the exploration of outer space. The idea of launching earth satellites had been promoted for several years by a small group of scientists in both East and West. In 1948 the advantages of such an effort had been outlined by Dr. Van Allen at the IUGG meeting in Oslo. In November 1953, A. N. Nesmeyanov, president of the Academy of Sciences of the USSR, told the World Peace

[13] CSAGI, *Bulletin d'Information*, No. 5 (IUGG News Letter No. 11, London, 1955), p. 60.

Council in Vienna: "Science has reached a state when it is feasible . . . to create an artificial satellite of the earth."[14]

URSI, in a resolution adopted on 2 September 1954, at The Hague, stressed "the extreme importance of continuous observations, from above the E region of extra terrestrial radiations, especially during the forthcoming A.G.I. [IGY]" and drew attention to the fact that

> an extension of present isolated rocket observations by means of instrument earth satellite vehicles would allow the continuous monitoring of solar ultraviolet and X radiation intensity and its effects on the ionosphere, particularly during solar flares, thereby greatly enhancing our scientific knowledge of the outer atmosphere.[15]

A similar resolution was passed later that month by the IUGG General Assembly in Rome, and two weeks afterwards CSAGI followed suit with a resolution recommending that "in view of the advanced state of present rocket techniques," consideration should be given "to the launching of small satellite vehicles, to their scientific instrumentation, and to the new problems associated with satellite experiments, such as power supply, telemetering, and orientation of the vehicle."[16]

Administration of the IGY

The core of the IGY administration was the Bureau of CSAGI, originally a three-man body consisting of Dr. Chapman, the president; Dr. Berkner, the vice-president; and Dr. Nicolet, the secretary-general. It was later expanded to include Dr. Beloussov, of the Soviet Union, and Dr. Coulomb, of France, as "members." Hence, as finally constituted, it included citizens of four great powers: France, the Soviet Union, the United Kingdom, and the United States.

The expansion of the IGY placed an increasing burden on the handful of men, under Dr. Nicolet, who operated the

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[14] *Pravda*, 28 Nov. 1953. Quoted in F. J. Krieger, *Behind the Sputniks, A Survey of Soviet Space Science* (Washington, Public Affairs Press, 1958), p. 3.

[15] URSI, *Proceedings of the Eleventh General Assembly*, Vol. 10, Part 8, Administrative Proceedings (Brussels, 1954), p. 74.

[16] CSAGI, *Bulletin d'Information*, No. 4, *op. cit.*, p. 179.

headquarters at Uccle. This office was financed in part as indicated in Chart A.

CHART A

Year	*UNESCO*	*ICSU*	*U. S. Academy of Sciences*	*Royal Society, London*	*Soviet Academy of Sciences*
1952	$ 1,400	—	—	—	—
1953	1,000	2,472	—	—	—
1954	2,000	6,448	—	—	—
1955	20,000	3,000	—	—	—
1956	15,000	14,500	20,000	7,000	15,000
1957	25,000	6,000	25,000	7,000	15,000
1958	25,000	6,000	25,000	—	15,000

The international administrative outlay for the peak period was only about $100,000 per year. Yet national program expenditures totalled "hundreds of millions of dollars."[17]

By March 1955, the number of participants in the IGY had grown so large that ICSU recommended formation of an Advisory Council, made up of representatives from all the participating nations, to advise and assist CSAGI on general IGY questions. From 8 to 14 September of that year, there was a plenary CSAGI meeting in Brussels, and the newly formed Advisory Council held parallel sessions with some 30 national delegations participating. The Council's areas of responsibility as defined by Dr. Chapman to the conference included arrangements for mutual assistance between nations, regional arrangements such as those being made for the Antarctic, and the allocation to various nations of responsibility for storing the data resulting from IGY observations. Dr. Chapman explained that CSAGI, representing the scientific unions, was strictly non-political and could not recommend that any nation assist another with funds, equipment, or personnel, or by permitting foreign nationals to work on its territory. But such arrangements, he said, could be worked out in bilateral discussions and be presented to the Advisory Council.[18] From then on the

[17] ICSU, *A Brief Outline, op. cit.*, p. 8.
[18] CSAGI, *Bulletin d'Information*, No. 6 (1956), p. 11.

Advisory Council met in conjunction with each plenary meeting of CSAGI.

Among other decisions made at the conference was the starting time of the IGY—zero hours, Universal (Greenwich) Time, 1 July 1957. A new pole-to-pole band of stations was also discussed, in addition to the three already decided upon. It would lie along 110° East, passing directly through the Chinese People's Republic, which had just joined the program.

Final Plans and Preparations

Meanwhile the Soviet Union had decided to give the highest priority to its IGY projects. A Joint Committee for the Implementation of the IGY was formed in 1955, under the Praesidium of the Academy of Sciences of the USSR, and on 2 November 1956 the Praesidium issued a decree stating that, in order to guarantee prompt and successful fulfillment of Soviet IGY commitments, priority was to be given to IGY projects in the allocation of workers, facilities, and instruments. (It is possible that this resulted in an even more extensive and intensive effort than that under way in the United States.) To ensure that this directive was carried out and that IGY funds allocated to the various institutions were properly used, the Praesidium on 10 January 1957 created a temporary "Consultative Committee for Preparing for and Implementing the International Geophysical Year at Establishments of the Academy of Sciences, USSR." The chairman was Professor A. G. Kalashnikov.

By early 1957, 28 institutes, observatories, committees, and societies of the Academy were preparing for the IGY. Beginning in March, the Consultative Committee carried out inspections of all projects except those in the most remote locations, one of its functions being to see that funds given institutions for IGY work were not being diverted into other projects. Priority was given to the inspection of stations whose observations would have to be made in strict synchronization with those in other countries.

The Consultative Committee drew up the detailed programs for the various institutions and for processing the resulting data by mechanical computer. It was also concerned with "an extensive propaganda programme" to popularize the IGY, its tasks and methods of observation.[19]

The final months before the start of the IGY were marked by a series of conferences dealing with regional problems or specific areas of IGY work. One of these, held in Stockholm from 22 to 25 May to coordinate Arctic research plans of all nations bordering on that region, led to a startling proposal: One of the problems in studying the drifting ice that covers the Arctic Ocean is the fact that no information is available—or ever has been—regarding the total distribution of this ice. Unlike the South Pole, which lies near the heart of a mountainous continent, the North Pole lies in the midst of an ocean. (This was dramatically illustrated when the United States submarine *Skate*, on its recent voyage to the North Pole, was able, on each of the nine days that it was under the ice, to find open water in which to surface. It did so even at the Pole itself.) The arctic ice moves constantly; one week it hugs the Alaskan coast, the next it shifts against the Siberian coast, leaving Alaskan waters ice-free. During the conference, the United States delegates proposed to the Soviet delegates a joint program of aerial photographic mapping of the ice, with exchange of the results to make possible a composite picture of the pack-ice patterns.

According to the delegates from the United States, the Russians responded with a suggestion that photo-reconnaissance planes of both countries shuttle back and forth between Murmansk, in the USSR, and Fairbanks, Alaska, making use of each other's airfields. These two points are located at opposite ends of the long axis of the Arctic Ocean. Hence, through varying digression from a straight line between

[19] V. S. Zaletaev, *Izvestia Akademia Nauk SSSR*, ser. geofiz. No. 7 (1957), pp. 965-7. English translation by P. J. Hyde (published by Pergamon Press for the American Geophysical Union [New York] with the aid of a grant from the National Science Foundation), p. 160.

them, it would be possible to cover the entire ocean. This would have set an important precedent for a disarmament program which, like President Eisenhower's "open skies" proposal, depended on aerial inspection.

A resolution adopted at the end of the conference read:

> The CSAGI Arctic Conference recommends that regular aerial photographic traverses of the Arctic Basin be carried out with the objective of securing comprehensive data on sea ice distribution, lead patterns, and degrees of ice concentration.[20]

In Washington, however, there apparently were misgivings about the Soviet suggestion of flying into Fairbanks. Soviet ferry pilots had landed there regularly during the war to pick up United States planes, but since then two important Air Force bases had been built near by. In September, four months after the Stockholm conference, a note was handed to the Soviet Embassy in Washington proposing that Soviet planes land at Nome (which is almost within sight of Siberia) rather than at Fairbanks.

During the weeks that followed—with the world preoccupied by the Hungarian and Suez crises—the Soviet government made its first official pronouncement on the ice-survey plan. In a note delivered on 21 November, it said, in effect that no help was needed by the Soviet Air Force in aerial photography of the ice on the Soviet side of the Pole and that if the United States Air Force was unable to do the job on its side, Moscow might consider helping out. This effectively killed the scheme, even though the Russians did extensive ice photography on their own, as did the United States to a more limited extent. It may never be known what might have happened had no world crisis arisen at just that moment and if the negotiations had been kept on a scientific level.

Another special IGY problem that came up for discussion was a proposal to study wind-borne radioactive fallout from nuclear-weapons tests. This had been made in 1955 by the Netherlands National Committee on the grounds that

[20] CSAGI, *Bulletin d'Information*, No. 7 (1956), p. 68.

as the pollution of the air by radioactive matter may in the long run become a serious menace to health and even might influence meteorological phenomena, it seems highly desirable to know the basic value of the radioactivity.[21]

Since the time, and sometimes the place, of origin of fallout can be determined, it serves as a tracer of air movements. It was this aspect that chiefly interested the weather men. Dr. Harry Wexler, head of meteorological research at the United States Weather Bureau, suggested injecting harmless amounts of radioactive material into the atmosphere for more precise study of its movement. Similar experiments with ocean currents were also proposed.

The fallout study was discussed at the Brussels conference in 1955 and was endorsed by the final pre-IGY conference of CSAGI, held in Barcelona from 10 to 16 September 1956. It was hoped that the results would throw light on vertical air movements, which otherwise are extremely difficult to detect. Observations were to be made of the nuclear radiation of the air, of the fallout reaching the ground, and of the dust already accumulated there. This might show how long bomb products could be expected to remain in suspension in the stratosphere.

An interim committee was formed at Barcelona to arrange for a network of collection stations and for standardization of methods. Scientists from the Netherlands, Sweden, and the United States were chosen by name, with the understanding that others would later be designated from Australia, Japan, and the Soviet Union. When the committee was convened in Utrecht from 22 to 26 January 1957, no Soviet delegate appeared. There was some indication that Soviet IGY leaders had recommended participation of the USSR but that the idea had been turned down in Moscow. Yet the Soviet Union was taking part concurrently in the work of the United Nations Scientific Committee on the Effects of Atomic Radiation, studying such questions as the danger of fallout to human welfare. Rejection of the IGY study may

[21] From a draft copy of the IGY history written by Sir Harold Spencer Jones for the forthcoming IGY *Annals*, Vol. 1.

have been a political decision in Moscow not to take part in any activity which implied that fallout had some usefulness.[22] In spite of the Soviet absence, the committee inaugurated a limited IGY program of fallout study.

Another conference, held in Uccle, Belgium, from 1 to 4 April 1957, dealt with the question upon which the success of all aspects of the IGY hinged—data exchange. Without free movement of the fruits of the observations across all national boundaries, there would be no point in having an IGY. This was reflected in a resolution of the 1955 Brussels conference that began: "The CSAGI resolves that all observational data to be exchanged in accordance with the IGY program shall be available to scientists and scientific institutions in all countries."[23] At these meetings, it was agreed that the data should be presented, as far as possible, in a form suitable for machine processing, but it was left up to working groups in each field of research to agree on just what data was to be exchanged.

The United States and Soviet Union both offered to set up and finance archives for all of the IGY sciences, and offers to do so for individual sciences were received from other nations. Hence it was decided to establish three World Data Centers (WDC's), each to house a complete set of IGY data. This, according to the decision of the Uccle conference, was designed (1) to insure against catastrophic destruction of a single center, and (2) to meet the geographical convenience of, and provide easy communication for, workers in different parts of the world. World Data Center A was to be in the United States, where it would be subdivided into about a dozen archives at institutions concerned with the various sciences. World Data Center B was to be in the Soviet Union, where it would be divided between Moscow and

[22] At the IUGG General Assembly in Toronto during the IGY, it was proposed that underground nuclear explosions, if announced in advance, might create shock waves that could settle such questions as whether or not the inner core of the earth is solid. The idea was forcefully opposed by Dr. Beloussov, who remarked that Soviet scientists were opposed to nuclear-weapons tests and that such studies could be done in other ways.

[23] CSAGI, *Bulletin d'Information*, No. 6, *op. cit.*, pp. 30-1.

Novosibirsk, in Siberia. World Data Center C was to be subdivided among countries in western Europe, Australia, and Japan. The chief weather archive was to be at WMO headquarters in Geneva.

In 1956 the CSAGI Bureau appointed Vice Admiral Sir Archibald Day, who had just retired as Hydrographer of Britain's Royal Navy, as IGY Coordinator. It was his task to see that the data centers were established and that the information reached them.

Promptness was recognized as an important element of the program, and it was decided that each WDC must send copies of all incoming data to the other two centers within two months of receipt, at no cost, unless the other centers had already received the same material. Actually, during the IGY many participating institutions sent their results to all three centers, obviating the need for later duplication.

Another decision of the Uccle conference provided that

> all WDCs shall satisfy within three months the demands of scientific bodies or investigators in any country for copies of material, or extracts thereof, reproduced in accordance with the rules of CSAGI. The fee charged for such material should not exceed the cost of copying and postage.
>
> Scientific workers shall have access to material available in each WDC by arrangement with the authority responsible for the WDC.[24]

It was envisaged that the collection of all data would be completed by the end of 1960. This was to allow time for expeditions to return and process their results.

During June 1957, dress rehearsals were held in many IGY programs, and a world-wide communications network to alert participants to flares on the sun was tested. All was set for what Dr. Chapman described as "the greatest example of world wide scientific cooperation in the history of our race."[25] But a political crisis threatened this program which had sought with such determination to remain non-political.

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[24] CSAGI Guide to IGY World Data Centers, draft of 7 June 1957 (mimeo.), pp. 1-2, and Sec. 1, pp. 2-4.

[25] *Ibid.*, p. 1.

China

THE CRISIS THAT marred final preparations for the IGY concerned the participation of the world's most populous nation —the Chinese People's Republic.

On 12 September 1955, Dr. Chapman, as president of CSAGI, reported to the CSAGI conference in Brussels on an exchange of telegrams with the Academia Sinica, in Peking, which had built a world-wide reputation for scholarship. The Chinese, he announced, had begun to form an IGY committee headed by Dr. Chu Cho-ching, vice-president of the Academia.

The message from Peking said that participation of the Chinese People's Republic was conditional on non-acceptance of the Chinese Nationalists as participants. This did not appear to be an obstacle since, three years after the initial invitation to participate in the IGY, no response had been received from Taiwan (Formosa).

Following the lead of the Soviet Union, the Chinese People's Republic used the IGY as justification for many-fold expansion of its observatories in the fields of weather, geomagnetism, and earthquakes. A list of IGY stations around the world, issued by CSAGI as of 24 March 1957, showed some 27 planned observation posts on the Chinese mainland, ranging from the coastal cities to Lhasa, in Tibet, and Urumchi (Tihwa), in Sinkiang.

A delegation of scientists from Peking took part in the IGY regional conference for eastern Europe and Asia, held in Moscow from 20 to 25 August 1956. The following month, science closed an eye to politics when delegations from mainland China and the USSR went to Spain, for the CSAGI conference in Barcelona.

About three months later a letter dated 1 November 1956 was received by Dr. Marcel Nicolet, as secretary-general of

CSAGI, from Dr. Chu Chia-hua, who identified himself as president of the Academia Sinica. The letter was postmarked Taipei, Taiwan. Thus there were two rival Academia Sinicas, represented by two Dr. Chus—one in Peking and one in Taipei. The latter, in his letter, noted that the Republic of China (on Taiwan) was a member of ICSU and protested the admittance to the Barcelona conference of "three agents" from the Chinese People's Republic.

> It is needless to say [wrote Dr. Chu] that there is no independent scientific institute in any country behind the iron curtain, and that it has been the manifest intention of the communist rulers to turn every international gathering, scientific or cultural, into an arena of transmitting malicious propaganda and a battle ground for waging cold war. . . .Nor is it necessary on my part to remind you of the fact that the Chinese communist regime has been solemnly indicted by an overwhelming majority of the United Nations as the aggressor in the Korea war. It is impossible to expect scientists from Free China to sit face to face with the so-called representatives sent by a regime which is responsible for the wholesale massacre of some 15-20 millions of their innocent fellow countrymen.[26]

Dr. Chu claimed that no communication from CSAGI had been received by the Taiwan Academia Sinica since CSAGI was formed. He said scientists in Taiwan were willing to cooperate in the IGY effort, but demanded deletion of the People's Republic of China from the official list of IGY participants.

Some of the IGY leaders expressed concern at this letter, since they felt that the Chinese Nationalists, having ignored the IGY for more than four years, had been induced to apply only by the news that the Chinese Communists were taking part. Every effort had been made to keep politics out of the IGY and, in the various preparatory conferences, the many political rivals in attendance had assiduously stuck to science. The letter from Taiwan raised an issue which, it was feared, might open a Pandora's box of East-West hostility. The ensuing controversy could wreck the IGY.

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[26] This and subsequent quotations in this chapter from unpublished CSAGI material.

Therefore, in January 1957, Dr. Nicolet reminded the Dr. Chu in Taiwan that his academy had been invited to join the IGY as early as 1952.

> You will realize [he added] that the International Geophysical Year organization functions through the initiative of individual scientists acting through committees, and that it is not organized through government action. Furthermore, it is the basic policy of the CSAGI, as formulated at its very inception, that participation in its program has no political significance and is without relation to political organization.

He added that the CSAGI secretariat "cannot deal with governmental problems since its activity is restricted solely to the central administrative action necessary to cooperative geophysical research."

On 5 February 1957, a message from Taiwan to CSAGI requested an invitation to a regional conference to be held in Tokyo, starting 25 February, to coordinate IGY plans for the western Pacific. It made no mention of Chinese Communist participation, although a delegation from Peking would obviously attend. However, the host Japanese National Committee for the IGY received a message from Peking saying, in part, "Will send delegates on the condition Taiwan not invited." The Nationalists, not yet listed as IGY participants, had not been sent an invitation. The Japanese notified Peking to that effect.

On 6 February Dr. Nicolet asked Taiwan by cable to transmit the membership of its IGY committee and a description of its scientific program—standard preliminaries to adhering to the IGY. Late the next afternoon the Nationalist Chinese Embassy in Brussels phoned IGY headquarters and asked why this message had been sent instead of an invitation to the Tokyo meeting. The Embassy was notified the next morning that no invitation was possible until the widely scattered members of the CSAGI Bureau could make a decision. On 8 February, after making three urgent phone calls, a representative of the Embassy called in person at Dr. Nicolet's headquarters to press Nationalist China's case. Consultations among some of the Western members of the

CSAGI Bureau showed a strong feeling that, before an invitation was sent, Taiwan should be required to give assurance that it would send scientists—not government representatives—and would not raise political questions.

On 10 February the Nationalists cabled to CSAGI the list of their IGY committee and the sciences in which observations were planned. This was followed by a letter, dated 20 February, from the committee chairman, Dr. Kenneth T. C. Cheng, giving details of the program and again requesting an invitation to Tokyo. Neither made reference to the barring of delegates from Peking, and it was thus hoped that a compromise might be effected.

During this crisis, Dr. Chapman was in Göttingen, Germany, and he consulted by telephone with others of the CSAGI Bureau, including Dr. Beloussov, who was in Moscow. On 12 February he sent a letter to the Chargé d'Affaires of the People's Republic of China, in London, requesting that its contents be passed on to the Academia Sinica in Peking. He noted the Academia's statement that adherence to the IGY was conditional on the exclusion of Taiwan.

> Up to that time [he wrote] no such stipulation had formally been made by any nation as a condition of its participation. It was incompatible with the principles of CSAGI and the IGY, in which the cooperation of all countries is invited, regardless of political issues. Whatever disputes there may be as to the legitimacy of governments and rights to territory, CSAGI can only rely on the work of the scientists serving the governments actually administering the different parts of the earth: only they can make the geophysical observations needed for the IGY.

Participation of Peking had been welcomed, "but without reference to the restrictive condition, which at the time was inoperative," since Taiwan, three years after being sent an invitation, had not then accepted.

Dr. Chapman told Peking of the two communications from Taiwan—the November letter expressing unwillingness to sit with delegates from Peking and the February message that did not mention Peking.

> CSAGI is now faced with this problem [he wrote]. Taiwan has at long last given its adherence, invited in 1952, to the IGY.

After seeking to have China excluded from participation—a request that CSAGI would not consider—and after indicating that its scientists could not confer with yours, it has requested an invitation to the Tokyo conference. As Taiwan is a member of ICSU, and it alone can organize geophysical observations in Taiwan, the principles of CSAGI require that its adherence to the IGY be welcomed and an invitation sent to Taiwan to attend the Tokyo conference. To do this, however, as matters now stand, would seem to involve the loss of the participation by your country in the IGY and in the Tokyo conference. CSAGI would deeply regret such a loss. The potential contribution by your country to the IGY is obviously much greater than that of Taiwan can be, especially in view of the very late adherence of Taiwan to the IGY.

Dr. Chapman proposed a compromise on behalf of CSAGI. The Nationalists, in view of their expressed hostility toward Peking, would be asked to pledge that they would send only geophysicists to Tokyo and would not "raise political issues, which should have no place in the meeting." If such a pledge were given, then Taiwan would be invited.

Dr. Chapman indicated reluctance to request such a pledge, however, until he had assurance from Peking of a similar withdrawal of its condition for going to Tokyo. It would be "most regrettable," he wrote, if Peking withdrew from the Tokyo conference after Taiwan had been asked and had agreed to drop its own political conditions for attendance. He noted that more than 50 nations had joined the IGY, "in a harmonious spirit, regardless of political issues." For example, both parts of divided Germany were represented.

He emphasized that his letter was sent in the name of all five members of the CSAGI Bureau (one of whom, Dr. Beloussov, was vice-president of the Soviet IGY Committee). He had consulted with Professor Beloussov, "and he agrees with the view that it is desirable to make this appeal in order to avoid the possible loss of China's cooperation in the IGY."

Meanwhile, the Nationalists persisted in their efforts. On 18 February a representative of the Embassy in Brussels again delivered a message asking for an early decision on its request for an invitation to Tokyo. This was relayed to Dr.

Chapman in Göttingen and, on 22 February, with still no reply from Peking, he wrote to the Nationalist Chargé d'Affaires in Brussels calling attention to the last-minute nature of the Chinese Nationalist bid, which was welcomed despite its tardiness. Nevertheless, he continued, it was "accompanied by requests of a nature contrary to the principles of CSAGI and the IGY." This was partly responsible for the delay in the original CSAGI reply and also presented "difficulties" in replying to the request for an invitation to the Tokyo conference. The making of a decision had been further complicated by the absence from Brussels of two of the five CSAGI Bureau members. Hence he doubted that the question could be resolved before the Tokyo meeting, due to begin in only three days.

On the day that it did open (with a Peking delegation in attendance), the Chargé d'Affaires in Brussels, R. H. Ouang, asked Dr. Chapman if Chinese Nationalist scientists could attend as observers. Dr. Chapman replied, in effect, that he could make no such arrangement on his own authority.

Meanwhile, on 18 February, a message reached Brussels from Peking as follows:

> Learned CSAGI intends admit Taiwan to IGY. This directly violates our previous understanding. China will join IGY only on condition Taiwan should not be admitted. Otherwise China will withdraw from IGY.
>
> Chu Chocching Chairman CN IGY.

This was probably in response to a cabled summary of Dr. Chapman's letter. According to Dr. Chu, he did not see the full text until the end of March, when he returned from a trip. In a letter to Dr. Nicolet dated 8 April, and one to Dr. Chapman two days later, he rejected their compromise plan.

> We realize [Dr. Chu wrote] that the I.G.Y. will accept all bona fide participants to the enterprise it has launched, irrespective of their political creeds; but is it not true that a man of science, as well as a person in any other profession, cannot very well disregard the national consciousness of his own countrymen? We Chinese are very apprehensive of the effort certain powers are making to create two Chinas to the detriment of their father-

land. The Chinese on the continent, and among them the Chinese scientists, therefore will recognize only one Chinese nation, i.e., the People's Republic of China, in existence in any international dealings and enterprises. We do not object [to] scientists from Taiwan coming to the I.G.Y. gatherings . . . as long as they agree to this stipulation, implicitly or explicitly.

He described the late adherence of Taiwan as a political move, "for they knew fully well that we would walk out as soon as they were officially admitted."

He argued that the splitting of Germany could not be compared to the Chinese situation, for Germany had been divided on the basis of international agreements growing out of World War II, while "in 1949 the Chinese people overthrew the old corrupt regime and established their own government. It is only owing to foreign intervention that there is the present temporary abnormal situation of Taiwan." Any qualified Chinese geophysicist would be welcomed as a member of the Chinese National Committee, he added, whether or not he resided on the mainland.

He noted that scientists from Peking had already taken part in three IGY conferences and had considerably enlarged their observation network, as requested by various conference resolutions. In a separate letter, on 8 April, Dr. Chu said that Peking would contribute to the CSAGI budget $7,500 in gold for each of the next three years.

No more IGY conferences involving the Chinese were scheduled before the start of the Year, and the Bureau had begun to hope that a showdown could be avoided. However, in his letter to Dr. Nicolet, Dr. Chu said flatly that Peking would take part in the IGY only "on condition . . . that there should not be two National Committees of China."

This proved to be the insurmountable difficulty, for all the Bureau members, with the possible exception of Dr. Beloussov, agreed that acceptance of Taiwan could no longer be deferred. In a message on 2 May the Taiwan scientists denied that their November letter implied political conditions and again asked that their admittance be expedited. This was elaborated in a letter two weeks later. Meanwhile

the United States had entered the picture. A letter had been sent from the National Academy of Sciences in Washington supporting the Taiwan application. Another letter from the United States assailed the view that "the end justifies the means"—clearly an argument against denying participation to a small power to gain participation by a large one.

The CSAGI Bureau, meeting in Uccle from 16 to 19 June 1957, decided to make one final attempt. Taiwan was quietly accepted, but at the same time it was announced to all IGY participants—without any stated reference to the Chinese problem—that henceforth no IGY committees would be listed in CSAGI documents as "national."[27] Letters explaining the situation were sent to Taiwan and Peking. Dr. Chapman, writing on 17 June, thanked the Peking Dr. Chu for his letter of 10 April and explained that a reply had been delayed until the Bureau could meet and discuss the problems that it had raised and that arose from a letter from Taiwan.

> It appears to the Bureau [Dr. Chapman said] that there will be IGY participation organized under the Academia Sinica, Taipei, which we must and do welcome. It cannot but be organized by a committee of scientists; this must be recognized in our list of participating IGY committees. As a whole these committees have been called national, for brevity, though we recognize that this term is not appropriate in all cases; the USSR IGY committee, for example, does not use the term national in its own title, because of the multinational character of the USSR. As regards Chinese IGY participation the Bureau has decided to include, in the list of participating IGY committees, two consecutive entries as follows:
>
> Chinese IGY Committee: Peking
> Chinese IGY Committee: Taipei
>
> The General Secretary will try to avoid the use of the word national in specific references to these two committees. He will also try to ensure that the same practice will be followed by the many others who in some official capacity may have occasion to refer to them. On your own documents the title of your committee is a matter for your own choice. In view of your

[27] *IGY News* (published by CSAGI), 15 July 1957.

references, which I was glad to see, to the IGY participation of overseas Chinese geophysicists, I sincerely hope that you will at least tacitly accept this course of action.

Dr. Chapman asserted that the inclusion of two Chinese committees had no political implications and concluded by saying: "The injection of political questions might even at this stage threaten serious dangers to the great IGY enterprise, in which so many geophysicists everywhere are eager peacefully to cooperate." The next day, Dr. Nicolet sent a letter along the same lines to Dr. Cheng, chairman of the IGY committee in Taiwan. The IGY was due to start in less than two weeks.

The Chinese Nationalists apparently objected to the compromise manner of listing the two Chinese committees. The Second Secretary of the Nationalist Embassy in Brussels on 19 June asked for an appointment with Dr. Nicolet to discuss "the participation of the National Committee of the Republic of China in the IGY program." The CSAGI Bureau turned down this request, stating that it should not discuss political problems with government representatives.

On 29 June, eve of the IGY, a cablegram arrived from the Peking Dr. Chu stating that Taiwan was an integral part of China and could not take part as a country separate from the People's Republic of China. He demanded that CSAGI revoke its acceptance of Taiwan; until such action was taken, Peking was withdrawing from CSAGI and all its activities.

Thus when the IGY began, at midnight the following day, the nation whose area ranks third in the world was officially not a participant. Nevertheless, China seems to have carried out all or most of the program originally planned. Satellite-tracking stations were set up across the country from Sinkiang to the coast. The new observatories went to work and, according to Chinese press reports, the number of people working in the geophysical sciences was expanded from 40 —most of them weather men—to 10,000. The roster of weather stations grew more than 20-fold to a total of 1,000. Geomagnetic and seismic networks were established and an

oceanographic research vessel fitted out.[28] While the Chinese were obviously feeding their satellite observations into Moscow, it was not clear to what extent their general geophysical data would be made available to the world.

Meanwhile, through at least the first half of the IGY, hope lingered that a way could be found to include mainland China officially. On 16 September 1957, after receiving a letter following up Dr. Chu's message from Peking, the peripatetic Dr. Chapman—then at the High Altitude Observatory of the University of Colorado—wrote to him again:

> By your request we shall with great regret remove your name from the list of IGY committees, but if it is in any way possible we would like to retain your participation. If there is any feasible step consistent with the principles that bind us, that could enable us to retain your participation, we should very much like to have an indication thereof from you.
>
> Collectively and individually, the members of the Bureau of CSAGI earnestly invite your continued IGY participation, and urge that you will put aside, in this connection, the political considerations which are at present an obstacle to this participation.
>
> In any case, however, we are willing, indeed eager, to promote the development of your geophysical science insofar as we can do so. We hope you will continue to execute the IGY program you had planned, and we wish to aid you in this by the supply of the IGY Manuals and in any other ways that may be helpful to you. Should you not rejoin us officially at this time, we wish to state that our doors will always be open to welcome your return should this be desired by you.
>
> We wish, in any case, that your country may share in the benefits later to be reaped from our great enterprise.

Dr. Chapman gently emphasized that he spoke for all the Bureau, including Dr. Beloussov: "This letter is written on behalf of the CSAGI Bureau, with our unanimous consent."

On 4 February 1958, a sharply worded message to Dr. Chapman from Dr. Chu in Peking called attention to the

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[28] Peking Hsin-hua News Release, 7 June 1957; Lhasa Jih-pao, 14 Aug. 1957; Shih-chia-chuang Jih-pao, 6 Sept. 1957; Soviet Bloc International Geophysical Year Information (U.S. Dept. of Commerce, Office of Technical Services, issues of 21 Feb. and 7 Mar. 1958). These reports were in part confirmed in 1958 by the visit of Dr. J. Tuzo Wilson, president of IUGG.

fact that as recently as 31 October 1957 Peking was still listed on IGY documents as a participant. Dr. Chapman replied with an apology, but even the Soviet members of CSAGI went on treating the Chinese withdrawal as "temporary" and referred to the continuing existence of an IGY committee in Peking.[29] Likewise, the Soviet press seems to have regarded Peking as a participant as late as May 1958.[30]

Dr. Pushkov, one of the two Soviet members of CSAGI, wrote Dr. Chapman in February 1958, reporting that data from China was not being received at the Soviet World Data Center. He proposed that the question of Chinese representation be settled by a secret vote in the IGY Advisory Council, which was due to meet in Moscow during the summer of 1958. Dr. Chapman replied that the Bureau had agreed to place this question on the Advisory Council agenda, but asked for suggestions as to how to avoid a political wrangle.

Actually, according to some of those who attended the Advisory Council meetings in Moscow, the question of participation of mainland China was never discussed, though why the matter was dropped is not clear. Thus, when the IGY came to an end, the Chinese People's Republic was still not a member, the one nation among 67 to withdraw. It was the only case in which the IGY was significantly affected by political considerations.

Of all those concerned with the problem of Chinese participation, none was in a more delicate position than Dr. Beloussov. Technically his role in the CSAGI Bureau was as a representative of IUGG, rather than of the Soviet Union, and when he acted with other members of the Bureau he theoretically did so on his own and in fact appeared to have considerable independence of action. Like the head of the Soviet IGY program, Dr. Bardin, Dr. Beloussov was a member of the scientific élite whose role in Soviet affairs, as brought out during the IGY, was more powerful than many outsiders had realized.

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[29] Letters to Dr. Chapman from N. V. Pushkov, 21 Feb. 1958, and from Prof. F. Davitaya, vice-president of the Soviet IGY Committee, 22 Feb. 1958.
[30] See Max Frankel in *The New York Times*, 19 May 1958.

The Geophysical Year Begins

AT THE APPOINTED hour on 1 July 1958, the great scientific adventure that was the IGY began. The crisis over China did not visibly dampen the enthusiasm of the IGY leaders, and few others knew of it, even, apparently, in China. Around the world, at zero hours, Greenwich time, scientists turned on recording instruments or checked their operation (many of the observations had begun 1 June as a dress rehearsal). The sun was shining on the central Pacific and, as anticipated seven years before, was nearing peak activity. A 24-hour watch on its spot-marked face had begun and was to continue, unbroken so far as weather allowed, for the next eighteen months. The task was shared by observatories in Alaska, Japan, Australia, the Soviet Union, western Europe, and the United States, so spaced around the world that the sun was always over one or more of them.

The IGY roster at that time included 64 countries. An estimated 30,000 scientists at 4,000 stations were taking part. In preparation for this day observers had been placed in the most remote parts of the earth—at the South Pole, on drifting floes near the North Pole, in huts perilously perched on mountain tops from Haut de Stalin, in Bulgaria, to Mount Eva Peron, in Argentina. (The tides of political fortune had made both names potentially obsolete, but they remained on IGY station lists.) Other scientists were on Mount Norikura, in Japan; at Tunchuan, in the mountains of southwest China; and on Sacramento Peak, New Mexico. The elevation of these stations above a large portion of the atmosphere made them more effective in receiving cosmic rays and other messengers from space.

Some IGY investigators went down instead of up, seeking knowledge of the earth's shape and interior. Many of those

studying day-to-day shifts in the force and direction of gravity were underground: Americans in a tunnel at Dalton Canyon in California, Germans in a potash mine, and Italians in a grotto near Trieste.

Those studying the strange changes in ocean level, which range from shifts every few minutes to seasonal variations, were installed on remote islands, sometimes mere patches of white coral with no other inhabitants except a multitude of sea birds. Research vessels from virtually all the large maritime nations were at sea or preparing for long voyages, according to a predetermined plan, to seek answers to such questions as the role of frigid and little-known currents over the ocean floors in bringing about climatic changes. Did something that happened a decade ago set in motion a force that will first influence climate some 20 years hence?

The sun was helpful in giving to the presumptuous inhabitants of its satellite, Earth, a good send-off in their attempt to fathom the nature of earth-sun relationships. Three days before the start of the IGY the observatory at Krasnaya Pakhra, 20 miles south of Moscow, observed the burgeoning ultraviolet light of a major flare. In accordance with the plan worked out in advance, Krasnaya Pakhra sent a specially coded message to the newly created World Warning Agency in Fort Belvoir, Virginia, recommending an "Alert."

When an "Alert" was called, the forecaster prepared a message, punched it on perforated tape, and inserted it in four teletype machines. The latter carried the alarm to the communications networks of the World Meteorological Organization (serving all weather stations), the United States Army Signal Corps (servicing Alaska, Antarctica, Australia, Canada, and Japan), and commercial companies servicing western Europe, Moscow, and Latin America. From Moscow the word was passed to eastern Europe and China; Tokyo relayed it to other Far Eastern stations. As a backstop the two time-signal radio stations of the United States National Bureau of Standards, WWV in Washington and WWVH in Hawaii, broadcast the warnings twice an hour. Britain's BBC broadcast them once a day on its Home Service.

An "Alert" was preliminary to the calling of a "Special World Interval"—a period for particularly expensive or difficult observations, for rocket shots, and for a redoubling of regular observations, in order to obtain a detailed picture of the flare's effect on the earth.

The World Warning Agency was not as imposing looking as its name sounded. It consisted of a cluster of shed-like structures on the edge of a lonely Virginia cow pasture. There technicians of the National Bureau of Standards made forecasts of radio propagation conditions. Since solar flares often cause radio blackouts, these men were experienced at deciding what kind of flare was likely to produce auroral fireworks and other manifestations on earth.

They were not entirely dependent on visual sightings. Solar flares produce bursts of radio noise that can be heard, even on cloudy days. Likewise a large flare causes sudden, intense ionization below the radio-reflecting layers of the ionosphere, swallowing up signals from distant points. By keeping track of signal strengths from stations in various directions and by vertical sounding of the ionosphere with radio signals, it is possible to detect the appearance of an absorption layer formed abruptly at the moment that light from a flare reaches the earth.

Besides an ionospheric sounder, the forecaster had before him a large globe whose surface was a blackboard. On it, in ten imposing clusters, were sunspots as reported from around the world during the sun's own rotation. Since the sun is gaseous, it does not rotate uniformly, like a solid sphere. Sunspots near its equator make the trip around a few days faster than those at higher latitudes.

When the sun came over the Virginia horizon, after the message from Krasnaya Pakhra, it was, indeed, remarkably pocked with spots and other manifestations of activity. Piecing together all available bits of information, the forecaster on duty, whose responsibility it was to decide, carried out the recommendation of the Soviet observatory and called an Alert. His decision was wise, for within seventeen hours the particles ejected by the flare began showering on the earth's

atmosphere, causing severe disruption to world-wide communications and radical fluctuations in the earth's magnetic field. The World Warning Agency then proclaimed a Special World Interval, and so the IGY began.

A particularly fruitful station was the Geophysical Institute at the University of Alaska, near Fairbanks. This had been one of the key United States observation points during the Second Polar Year, for it lay close to the zone of maximum auroral activity. During that earlier effort it was a meagerly equipped outpost. By the start of the IGY it was one of the world's most modern geophysical observatories. Much of the recording was done automatically, 24 hours a day. Even while their masters slept, the instruments hummed and clicked, trembling needles inscribed lines on moving rolls of paper, recording hidden pulses in the earth and the space around it. Information was also captured on film and magnetic tape. The subtle symphony of electronic sounds emitted by these instruments symbolized the completely mechanized probings typical of the IGY.

Among the devices was one that measured the flow of electricity through the crust of the earth. This clearly forms a part of the earth's great electro-magnetic mechanism, which is so sensitive to events on the sun. The currents in the vicinity of the observatory tend to flow in either direction along a line 30° to the west of true north. Their strength, as a rule, is about four volts per 1,000 yards. But when the particles ejected by a flare disrupt the earth's magnetic field, the current behaves wildly. The gear was so rigged that when the fluctuations became extreme a buzzer was sounded beside the bed of a scientist, who could then rouse his colleagues to begin observations of the aurora and other phenomena subject to the same influences.

The aurora was observed in several ways. By the time the IGY began, some 80 all-sky cameras had been sprinkled over the top of the globe. At that season there was no night in the central Arctic, but 12 of the 13 cameras set up from coast to coast across the United States were reported ready for automatic photography throughout the hours of darkness. They

were so spaced as to cover the entire sky spanning North America. The Soviet Union reported that it had 30 such cameras along its northern coasts and at its two drifting stations on the Arctic ice floes. Another 14 were reported ready in northern Europe, 4 in Greenland, 11 in Canada, and 8 in Alaska and at the two United States drifting stations on the Arctic Ocean.

Daylight was not necessarily an obstacle, since the aurora can be observed by radar when the radar beam strikes the curtains of light roughly at right angles to their "hang." This type of observation was being carried out by the more elaborately equipped stations, such as that at the Geophysical Institute in Alaska. Similar auroral observations, by camera, spectroscope, radar, and other devices, were being made at the Antarctic stations. Clearly the two auroral zones were opposite ends of a great mechanism, but its nature was obscure. It would be of interest, for example, to see if the displays coincided in time, character, and distribution.

In the Antarctic, too, a network of seismographs had been placed in operation which promised to determine for the first time, the seismicity of that continent—its lines of earthquake centers, and hence, the pattern of cracks in the southernmost part of the earth's crust. Likewise, the glaciologists in the Antarctic, kept at their stations by the continuous darkness of winter night, were seeking clues to past climate and to present trends by digging deep beneath their camps. Shafts, gouged into the ice at such points as the South Pole and Wilkes Land, served the dual purpose of supplying water and scientific information.

To extend the reach of weather stations the world over as high as possible into the atmosphere, radiosonde balloons of unusual size and strength were distributed for use especially on World Days and World Meteorological Intervals.

Thus the IGY began, carried forward by a seemingly irresistible tide of scientific enthusiasm. Many saw in it a great hope for mankind in setting a pattern of cooperation that could lead to permanent peace. In a television lecture on IGY-eve, Prince Philip, Duke of Edinburgh, said:

> The IGY is the world studying itself. It is seldom that this world of ours acts together. . . . Yet, for the next eighteen months, east and west, north and south, will unite in the greatest assault in history on the secrets of the earth. . . . At the same time, it may well help to solve the real problem—the conflict of ideas.[31]

Dr. Kaplan, chairman of the United States IGY Committee, declared that "these large views which are characteristic of astronomy and geophysics have given the IGY a role which may far transcend the gathering of data and the observing of physical processes."[32] In the Soviet Union, Dr. Bardin, chairman of the Soviet IGY Committee, said the Year would

> demonstrate once again that the cultural and scientific interests of all nations have a common base and that only international cooperation will solve the intricate and complex problems with which science today presents man.[33]

On 4 October 1957, the experts' interest in the IGY suddenly spread to the great masses of the world's population. A huge rocket thundered into the sky, reportedly from near the village of Kapustin Yar, 60 miles southeast of Stalingrad, arching northward as it rose out of the atmosphere, and injected into orbit the first artificial earth satellite. Moscow said this feat had been made possible through use of its newly developed intercontinental ballistic missile.

In the consternation that ensued in the West, either it was forgotten that the satellite launchings were part of an international scientific effort or there was a strong feeling that the Russians had not played the IGY game according to the rules. There had been no advance notice from Moscow as to the time and place of the launching, and the information issued after the event was meager compared to that published by the United States months before its first scheduled attempt. Whether or not the Soviet Union lived up to its commitments on the satellite program is discussed next.

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31 *Illustrated* (London), 27 July 1957, pp. 26-7.
32 Address at Wilson College, *op. cit.*, p. 11.
33 "The International Geophysical Year," *USSR*, No. 9 (1957), p. 39. Abridged from the magazine *Ogonyok*.

Sputniks

On 16 April 1955, six months after passage of the CSAGI resolution urging the launching of satellites and three months before the White House in Washington announced the United States program, the newspaper *Vechernyaya Moskva* told of Soviet plans to launch such a vehicle. The article described the formation of a permanent inter-departmental Commission on Interplanetary Communications under the Academy of Sciences of the USSR, with L. I. Sedov as chairman.

"One of the immediate tasks of the Commission," the report said, was "to organize work" on construction of a scientific earth satellite. Among the functions of the satellite were to be biological study of weightlessness, observation of ultraviolet light and X-rays from the sun and stars, study of the effect of the ionosphere on radio signals from the satellite, and photo-reconnaissance of polar ice floes and cloud cover. However, no timetable was given and there was no mention of the IGY.[34]

This report was virtually ignored by the rest of the world. However, wide attention was given to the announcement, made at the White House on 29 July 1955, that the United States planned such launchings during the IGY. Six weeks later, at the CSAGI conference in Brussels, Dr. Homer E. Newell, of the United States, gave a lecture on his country's program. Repeatedly, he used the word "modest" to describe the proposed satellites. It was "probable" that the launching of a satellite weighing as much as 100 pounds was "more than can be expected" during the IGY. "In its thinking and planning," he said, "the US National Committee has considered the possibility of six to ten satellite vehicles." The

[34] English translation in Krieger, *op. cit.*, p. 330.

Committee, he added, had consistently regarded the satellite project as "simply an extension of the conventional rocket program, which in turn has been thought of as an integral part and natural extension of the over-all IGY effort."[35]

This seems, indeed, to have been the spirit of the United States program at this stage. It was just another scientific project—simply more dramatic and exciting than others. The Air Force and Army had ballistic missiles at advanced stages of development, but it was decided not to meddle with the high-pressure effort to produce missiles. Instead, a special minimum-cost satellite-launching vehicle was ordered, to be developed under Navy supervision. The long process of design, construction, trial, and error had to be started from scratch. The project's code name was Vanguard—which was to afford Mr. Khrushchev an opportunity for a wry quip. Not a single full-fledged Vanguard satellite was launched during the IGY, although there were many tries and the launching vehicle went through its paces perfectly on one shot, placing a small test sphere in an orbit that may endure for two centuries.

Four days after the White House announcement, Academician Sedov, in Copenhagen for an astronautical congress, held a press conference at the Soviet legation. He noted the United States announcement and said that "much consideration" had recently been given in the Soviet Union to research on satellite launchings.

> In my opinion [he declared], it will be possible to launch an artificial earth satellite within the next two years. . . From a technical point of view, it is possible to create a satellite of larger dimensions than that reported in the newspapers which we had the opportunity of scanning today. The realization of the Soviet project can be expected in the comparatively near future. . . . It seems to me that the time has come when it is possible to direct all forces and means toward mutual efforts for creating an artificial satellite and to switch the military potential in the technology of rockets to the peaceful and noble

[35] Speech of 9 Sept. 1955, reproduced in CSAGI, *Bulletin d'Information*, No. 6, *op. cit.*, pp. 73-9.

purposes of developing cosmic flights. I think that such work would be an important contribution to the cause of eliminating the cold war and would serve the cause of consolidating peace.[36]

An official announcement was made about a year later, at the CSAGI Barcelona conference, in September 1956, by Dr. Bardin, the chairman of the Soviet IGY Committee:

The USSR intends to launch a satellite by means of which measurements of atmospheric pressure and temperature, as well as observations of cosmic rays, micro-meteorites, the geomagnetic field and solar radiation will be conducted. The preparations for launching the satellite are presently being made. . . . Since the question of USSR participation in the IGY Rocket-Satellite observations was decided quite recently the detailed program of these investigations is not yet elaborated.[37]

During the Barcelona conference, Dr. Bardin took part in a sixteen-man Working Group on Rockets and Satellites which included eight scientists from the United States, two from the United Kingdom, and one each from Australia, the Chinese People's Republic, France, Switzerland, and the Union of South Africa. Dr. Bardin was the only Soviet representative. Among the resolutions adopted by the group, and ultimately by the full CSAGI, were three that imposed specific obligations on satellite-launching countries. They were:

It is RESOLVED that the National Committees of countries having satellite programs be requested to provide to CSAGI, or directly to any country requesting it, full technical information on optical and radio tracking equipment—and on telemetry equipment as appropriate.

It is RESOLVED that the National Committees of countries having satellite programs be requested to provide to CSAGI, or to any country requesting it, such scheduling and planning information as is essential for the preparation for and execution of optical and radio observations.

It is RECOMMENDED that for *all* IGY satellites the radio systems employed for tracking and telemetering be compatible with

[36] *Pravda*, 5 Aug. 1955. English translation in Krieger, *op. cit.*, pp. 330-1.
[37] Quoted by F. J. Krieger, *op. cit.*, p. 6.

those which have been announced at the current CSAGI meeting [i.e., those of the United States] in order that the same ground-based receiving equipment can be used throughout.[38]

Those in attendance reported that Dr. Bardin, a metallurgist, did not seem familiar with satellite problems and acceded to the various Western proposals without argument.

During the months that followed, IGY leaders were anxious to receive details of the Soviet satellite program so that documents could be prepared for the use of the many nations that planned to take part in tracking. Finally, after a number of appeals to Moscow, a long document was received from Dr. Bardin on 16 June 1957, dated six days earlier. It discussed at length the scientific problems to be attacked in the Soviet rocket and satellite firings, but gave little information on the firing schedule itself.

It said the "satellites" would be launched from within the USSR in an almost north-south orbit, so that they would pass over all parts of the earth except the central areas of the Arctic and Antarctic. Rockets were to be fired from three "zones":

(1) Franz Joseph Land in the Arctic (25 launchings in 1958);

(2) "Middle latitudes of the USSR, 50°-60° North" (30 launchings in 1957; 40 in 1958);

(3) Antarctica, mainly near Mirny (30 launchings in 1957-58).

Some of the instruments in the rockets were to be housed in containers in the nose, which would be jettisoned at an elevation of about 125 miles and recovered.

Meanwhile, in that same month, the Soviet publication "Radio" printed two articles which revealed that the Soviet satellites would send pulsing signals alternately on two frequencies—20 and 40 megacycles—with a radiated power of about one watt. The nature of the telemetering system that would radio to earth the instrument readings within the

[38] CSAGI Rocket and Satellite Conference (Washington, 30 Sept.-5 Oct. 1957), Doc. 5 (mimeo.), 25 Sept. 1957, p. 7.

vehicle was described in general terms. The articles were designed to enable radio clubs and other groups of radio amateurs or science students to construct equipment to monitor the satellites. Unfortunately, these articles were not translated and circulated in the West until a week or two before the first Sputnik was launched. According to one CSAGI Bureau member, Moscow sent the same information to CSAGI by mail but its processing was delayed because the addressee was absent on a trip.

On 30 September 1957, a conference opened in Washington to coordinate final rocket and satellite plans for the IGY. Those attending represented nations taking part in rocket and satellite launchings (Australia, Canada, France, Japan, the Soviet Union, the United Kingdom, and the United States) and those with special tracking stations (Chile, Cuba, Ecuador, India, Iran, and Peru).

The United States scientists were disturbed to learn, just before the conference, that the Russians planned to use 20 and 40 megacycles, instead of the 108 megacycles to which the United States satellites and their tracking stations were tuned. It was argued that the proposed Soviet frequencies were not "compatible" with the United States equipment in the sense of the Barcelona resolutions. Furthermore, they said, 108 megacycles was better for tracking, since radio beams of that frequency were less subject to bending during passage through the ionosphere.

The Soviet delegates contended that far more could be learned about the ionosphere from 20 and 40 megacycles, used in tandem. The tracking system they described was based on the use of doppler—a change in signal frequency due to the component of satellite motion toward or away from the station. The Russians apparently did not intend to use the more elaborate interferometer technique of the United States minitrack stations. Pressed by United States scientists, the Russians reportedly said they might consider using 108 megacycles in one of their later satellites but could not change their plans on the early ones. This encouraged

the suspicion that they were almost ready to fire. Actually, at the start of the conference, the chief Soviet delegate, Anatoli A. Blagonravov, reported in Russian that a Soviet satellite would be launched in the immediate future. Unfortunately, the import of his remark was lost in translation.

The United States delegation to the Washington talks of some eighteen scientists presented a series of papers on the United States rocket and satellite program. Since neither the research rockets nor those being prepared for launching satellites were of military design, extensive details were given, including the nature of the fuels. One of the few items kept secret was the composition of the solid fuel to be used in the third stage of the Vanguard satellite-launcher. Dr. John P. Hagen, director of Project Vanguard, emphasized the problems inherent in using an untried vehicle, but said that small, uninstrumented spheres would be placed in the noses of rocket assemblies fired in the final four tests, adding:

> It is relatively unlikely that any of these test spheres will actually go into a sustained orbit. In a three stage vehicle of this kind, a great many components and pieces of equipment must work perfectly, all at the same time, in order for the flight to be successful. The probability of such a complex system operating perfectly during the first few realistic tests is extremely small.[39]

The Soviet delegates were clearly better briefed on satellite matters than Dr. Bardin had been in Barcelona. Although their papers on the subject dealt almost exclusively with the scientific problems to be investigated, several detailed reports were presented on Soviet rocket research prior to the IGY—a fact that seemed to augur well for fulfillment of IGY data-exchange provisions.

Data Exchange Proposals

It was at this conference that the long sequence of discussions on the exchange of satellite data began in earnest.[40] De-

[39] Speech of 30 Sept. 1957. Unpublished CSAGI material.
[40] Quotations from successive drafts from unpublished CSAGI material.

bate centered on the wording of the chapter of the CSAGI Guide to IGY World Data Centers on rockets and satellites.

On 29 November of the previous year, Vice Admiral Sir Archibald Day, as IGY Coordinator, had sent to the Reporters, named to coordinate plans in each of the IGY sciences, a series of skeletal chapters for the Guide. He described each as "little more than an introductory stage" and asked every Reporter to submit a detailed version. Among the points made in Sir Archibald's section on rockets and satellites was that the launching country would process observations of its satellites made by other countries. And the launching country would be required to make public within a week "details of each firing with an estimate of its scientific value."

The person in the key position of Reporter for Rockets and Satellites was Lloyd V. Berkner, president of ICSU. On 19 December 1956, he circulated to all concerned, including Dr. Bardin, his redraft of the chapter sent to him by Sir Archibald. It was really an entirely new document. The Berkner draft proposed that the launching country be required to submit, *inter alia*, the following information (paraphrased except where in quotation marks):

ROCKETS

(1) Launching sites and firing schedules.

(2) Data must be submitted to the World Data Centers for international distribution "within a few weeks" after each rocket firing or series of firings, giving rocket type, trajectory, weight, radio frequencies, and preliminary information on experimental results. Final conclusions on the interpretation of the results will be published in journals of "general availability" (no deadline given).

SATELLITES

(1) Tracking information, including "methods of data encoding."

(2) Launching site.

(3) "Information as to approximate period of launchings so that nations may have their ground station equipment in readiness."

(4) Announcement of each launching within one hour, and a report "as to success of orbit attempt" within the next three hours. (It takes 90 minutes for a complete orbit.)

(5) Precision orbital data to be published within five months.

(6) "A complete tabulation of the reduced, calibrated, and corrected data derived from the telemeter records of each experiment will be made available to the World Data Centers within eight months after the launching of that experiment." In cases where the experiment is prolonged, as when sun-powered batteries are used, the deadline for bi-monthly data increments will be eight months. Original telemeter records will be retained by the experimenters to be accessible to other scientists "for assurance against misinterpretations."

At the end of June 1957, this draft was made public by the CSAGI Bureau with the statement that it had called a rocket and satellite conference for the next fall at which the manual on this subject would be finally revised. "The nations concerned," it added, "have, however, basically agreed on the interchange of rocket and satellite data in accordance with the paper attached." The paper was the Berkner draft. How firmly the Soviet Union was committed to this document is not clear. On 10 July, Sir Archibald issued a draft section on rockets and satellites for the CSAGI Guide embodying all of the principles outlined above from the Berkner version.

However, at the fall meeting in Washington, the Soviet delegates insisted on a number of changes, and some were apparently suggested by other delegates, too. Principal among the alterations were the following: (1) Instead of "a few weeks," the deadline for rocket data was made "two weeks," with no obligation to furnish all of the flight information if it was not "readily available"; (2) the requirement that the satellite launching site be identified was deleted. Only successful launchings had to be announced, and the deadline was increased from one to two hours.

Remaining key provisions of the proposed draft were accepted unanimously. The atmosphere of the talks was cordial and the resolutions seemed to presage a prolonged pe-

riod of cooperation in rocket and satellite research. They provided for: exchange of rocket equipment and satellite instruments among participating nations; a compromise recommendation that all nations concerned prepare to monitor satellites on both the Soviet and United States frequencies; a special world rocket shoot to be held on 18 June 1958; rapid dissemination of data on satellite orbits; formation by CSAGI of an Advisory Committee on Rockets and Satellites to carry on the type of coordination provided, on a short-term basis, at the conference.

Most important of all, the resolutions foresaw the creation of a permanent ICSU organ to direct space exploration:

> Not only should future programs for rockets and satellites be developed promptly, but also means of international coordination, planning and standardization will be required. The coordination of rockets and satellite programs under the IGY will terminate at the end of 1958, and future means of international direction of such programs will be required.

The conference recommended that the International Scientific Unions and the ICSU develop suitable means "in the same general manner as initiated under the IGY."

The Space Age Begins

At the end of the final day of working meetings the participants were invited to a reception at the Soviet Embassy. It was during this social interlude that the author was called to a phone and told by his office that Radio Moscow had just reported the successful launching of a satellite. A whispered word in Lloyd Berkner's ear enabled him to announce the news to the assemblage. The next day, at the closing plenary meeting, Dr. Blagonravov gave a brief description of the satellite, after noting that it was Soviet policy to reserve comment on such developments until success was assured.[41]

The even greater weights of subsequent Sputniks, combined with the announcement that ICBM's were being used

[41] *IGY News, op. cit.*, Section VI, Item 61, 9 Nov. 1957, p. 157.

to launch them, pointed up the fact that the Soviet government, far from requiring its scientists to orbit their instruments with a specially developed rocket combination, had allocated for the task that nation's most powerful military rocket. The effect in the United States was to set in motion a parallel satellite program in which the Army was made responsible for the launchings. This led to the successful orbiting of a series of small but ingeniously instrumented Explorer satellites which made the most dramatic discovery of the IGY—a belt of intense radiation girdling the earth in space.

The impact of the Sputniks on the world is difficult to exaggerate. It produced a speeding up of the United States' efforts to develop long-range missiles, in addition to other excited reactions that could not but have had repercussions on the Soviet leadership. This presumably led to a general tightening up in the Soviet Union that may have contributed to some of the subsequent data-exchange difficulties.

Although Radio Moscow regularly broadcast predicted times of satellite passage over various cities, scientific circles were disturbed when no messages were received from Moscow giving orbital data, as had been expected on the basis of the data-exchange agreements. In mid-October, CSAGI headquarters requested data from the Soviet IGY Committee, which replied that it hoped to send some in early November.

In making plans for satellite tracking, United States scientists had thought that modern computers would make it possible to work out orbit characteristics on the basis of a few sightings. Actually it took them almost a month to get good orbital predictions on Sputnik I. Their work was made more difficult by the fact that the chain of radio-tracking stations extending from Maryland to southern Chile had been laid out to observe a satellite in a low-latitude orbit sending signals on 108 megacycles. All of these minitrack stations had to be rearranged to monitor Sputnik on 20 and 40 megacycles in an orbit inclined at about 65° to the Equator.

Meanwhile, it became evident that the first Sputnik had been launched before the Russians themselves were fully prepared to track it. For some months afterward, their periodicals described efforts to complete construction of the photo-tracking system. Observatories in the West, such as a giant radio telescope at Jodrell Bank in England, found that by phoning the Academy of Sciences in Moscow they could get short-term orbital predictions.

On 25 November, Dr. Bardin sent to CSAGI, for distribution to all IGY Committees, proposed codes for rapid circulation of information on satellite orbits. He hoped the data could be sent via the globe-girdling teletype net of WMO. This was seen by hopeful Western scientists as evidence that the Russians were in earnest about carrying out their IGY obligations with regard to satellites.

In January Sir Archibald visited Moscow in his role as expediter of data exchange and was invited to sit in on two sessions of the Soviet IGY Committee. He had sent around a new draft of the rocket and satellite chapter for the CSAGI Guide on 10 October, embodying the changes proposed at the Washington conference earlier that month. Now, however, he was presented with a document that read like a list of proposals for improving data exchange but that, he was given to understand, was to replace entirely his draft of the chapter. The points made by the Soviet paper were as follows (summarized):

(1) As launcher the USSR would supply orbital predictions in exchange for visual, optical, or radar data. This should be done via direct communications between Nizmir (the Institute of Terrestrial Magnetism, Ionosphere and Radio Propagation in Moscow) and the observing stations.

(2) The above procedure was the correct interpretation of the Washington resolutions, rather than Sir Archibald's proposal that observations be exchanged between World Data Centers. The United States had not asked for Soviet observations and it was disappointing that no observations had been received from the United States.

(3) Although the proposed Soviet code had been accepted by Alan Shapley, Reporter for World Days and Communications, it was disappointing that use of the WMO net had not been authorized. The USSR was willing to pay for its outgoing messages and those sending in data should pay for theirs.

(4) Preliminary reports on Sputniks I and II would be available in a few weeks; detailed conclusions would come later. The exact form in which to give orbital data was not yet settled.

(5) Arrangements for the United States satellites would be similar. Visual observations of any satellite could be sent to countries other than the launcher.

(6) No need was seen for a meeting to discuss these points.

The United States felt the proposed replacement of the chapter with such a loose directive was contrary to the spirit of the IGY and the Washington resolutions. Proposed revisions were sent to Sir Archibald incorporating those Soviet ideas acceptable to the United States, and this led, on 28 February, to his circulation of a new draft.

Among the items of information the new draft called for was the weight of all objects placed in orbit. This last question had arisen since in practice as many as five pieces of hardware went into orbit at a single launching: the instrumented satellite, the rocket that injected it into orbit and in so doing reached orbital velocity itself, and three sections of shielding that protected the satellite during ascent through the atmosphere but were later jettisoned. The carrier rockets proved to be the most easily seen of the objects, and hence the best suited to air-drag studies that would indicate the density of the atmosphere on the fringes of space. Such studies required information on the weight, shape, and dimensions of the object. Furthermore, data made public on experiments was to be in the form of detailed tabulations, rather than general interpretations. For a satellite-borne cosmic-ray counter, for example, the counts per second should be given for every minute of the flight, with geographical coordinates, elevation of the satellite, and the time.

In the second week of March, Dr. Beloussov reported that the Soviet Committee could not agree to any additions beyond the draft presented to Sir Archibald in Moscow. The United States almost immediately replied that it would not accept the latter version. In the face of this impasse Sir Archibald proposed that the CSAGI Guide include a provisional version of the chapter based largely on his latest draft but omitting three paragraphs, at least one of which seemed clearly contrary to the Moscow point of view. A footnote by Dr. Berkner presented possible versions of these paragraphs (concerning precision photo-tracking and detailed data from the satellite-borne instruments).

Also incorporated by this time were several changes favored by both Soviet and United States scientists, who had found the original data exchange schedule impractical. Rocket firing reports were called for "within four weeks if possible" (instead of within two weeks). Satellite launchings, with initial orbital data, were to be announced within 24 hours (instead of two hours). Preliminary reports on scientific experiments were to be published within "several weeks" after launching and full reports on both rocket and satellite experiments within a year "after the end of the experiment or investigation" (instead of eight months after launching or collection of bi-monthly data increments). Still included was the requirement to make public information on all orbited objects.

This version was circulated on 2 April 1958. On 20 May, Professor E. K. Fedorov, chairman of the Soviet Working Group on Rockets and Satellites, wrote rejecting Sir Archibald's earlier draft of 28 February. "To our mind," he said, "the Guide should be a distinct and brief document which clearly defines the order of this or that operation." He argued that the draft did not spell out what observational material was to be sent by other nations to the launching country. "Moreover," he wrote, "your Draft Guide denotes the obligations of the countries that launch rockets and satellites, and with some of these obligations we cannot agree." Among them he cited the alleged requirement that unprocessed data

be delivered, and noted that this involved "many kilometers" of film whose analysis by anyone except the launcher would be difficult.

We feel sure [he continued] that the publication of the detailed data about the methods and equipment used and of the results of observations in the usual routine adopted in all the scientific researches will provide every opportunity for any scientist to make use of the scientific information received with rockets and satellites.

Some of the data indicated in your Draft Guide for forwarding to the WDC are not connected with geophysical researches.

All these questions were discussed in detail at our meeting in Moscow in January 1958. And we keep to the opinion that the variant of XI Section of the Guide [on rockets and satellites] that has been worked out with you in Moscow is at present the most acceptable.

It was felt in the West that the Soviet committee had misinterpreted some of the provisions of the Guide. For example, there was no requirement that raw data be transmitted. It was decided to let the matter ride until the Moscow conference at the end of July.

When that meeting convened, a working group was formed to thrash out these problems. It proved impossible to achieve complete agreement, although a resolution was passed accepting most of Sir Archibald's 2 April draft, including all of his timetables. The points of controversy were disposed of as follows:

Satellite launching sites: In the April draft the obligation to announce these had been dropped in favor of making public the location of the point in space "at which orbital velocity was first established." But apparently the Russians feared that the launching site could still be determined by backward computations from such data. Hence, in Moscow this was changed simply to require the country launching a satellite to give the time and location of one reference point in the orbit from which scientists in other nations could predict its flight.

Size and Weight: It was agreed that the size and weight of the satellite itself should be announced, but an impasse was

reached on other objects, such as the nose cone and carrier rocket. Hence a United States comment was appended to this paragraph, flatly calling for the size and weight of all "significant objects" placed in orbit. Rather than unequivocally refusing such information, the Soviet delegation appended this comment: "Although the satellite is the primary object for scientific observations, information about the rocket carrier which is necessary to organize its observation should be given by the launching country in the form appropriate to that country."

Codes and Communications: The Reporter for World Days and Communications was assigned the task of coordinating the orbital data codes proposed by various nations. He would also negotiate with WMO regarding use of the weather network for transmission of such data.

Data: A revision of the earlier drafts called for transmission to the World Data Centers of "the observational data concerned, including those received by telemetry from scientific instruments carried in the satellite as well as those obtained by means of external observations." The material should be fully corrected and processed, so that any outside scientist could use it.

Appended to this section was a notation that "the U.S.S.R. propose to send data only on request in any particular case. The U.S.A. prefer the above wording which implies sending all data without any specific request."

In a separate resolution at the Moscow conference the full CSAGI Assembly expressed the hope "that an agreement will be reached for the kinds and amounts of Data to be sent to the WDC by the participants in the Rockets and Satellites program."[42]

Other resolutions adopted at the same time looked toward the day when space near the earth would be congested with long-lived satellites, some of them with sun-powered radio transmitters crowding out communication channels on earth. It was proposed that nations study means to destroy such transmitters and remove superannuated satellites from orbit.

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42 Resolutions of the Fifth CSAGI Assembly, Moscow (mimeo.), Doc. 170.

It was also proposed that "some group" be made responsible for coordination of the frequencies used in such satellites.

The earlier proposal for a permanent agency to coordinate space exploration was also revived:

> The CSAGI notes that in principle there is need for international planning and coordination of scientific experiments and observations in both rockets and satellites and, therefore, the CSAGI recommends that there be established a permanent committee to carry out such planning and coordination in as much detail as possible.[43]

Contributing Factors

Thus, at the end of the IGY, there was still no complete agreement on the question of satellite data exchange, although compromises had been reached on several aspects of the problem. United States scientists came away from the Moscow meeting with profuse ground observations from Soviet satellites, and by then several interpretive reports had been published in the Soviet Union. It was still hoped that once the radioed data from United States satellites had been published, the USSR ultimately would follow suit.

The chief factor affecting the Soviet attitude seems to have been the involvement of the military. The Soviet intercontinental ballistic missile was, to a large degree, Moscow's answer to the ring of United States bases facing the Soviet perimeter. Its characteristics were one of the most closely guarded secrets in the USSR. Furthermore, photographs and air-drag studies of the orbiting final-stage rockets of Sputniks I, II, and III suggested to United States scientists that they were the Soviet equivalent of the German V-2 rocket—another weapon from Moscow's arsenal. Hence it was decided that launching sites would not be made public, nor would any characteristics of the equipment used to achieve orbital velocity.

In addition, the Soviet leaders were presumably suspicious of a satellite data-exchange program "made in U.S.A." The

[43] *Ibid.*

alarm provoked in the West by the Sputniks and the resulting acceleration of missile development may also have helped to bring the data question into the loftiest area of Kremlin policy-making.

The meagerness of the data issued may have been due, at least in part, to the fact that the Russians did not have it. They apparently had not given so high a priority to preparations for tracking and analysis as they had to getting a satellite into orbit. Furthermore, like their United States counterparts, they seemed to have found orbit analysis—in practice—more difficult than they had expected.

Research with rockets and satellites was, however, only one of the twelve scientific disciplines with which the IGY was concerned. The other programs—in meteorology, geomagnetism, aurora and airglow, the ionosphere, solar activity, cosmic rays, glaciology, oceanography, seismology, gravimetry, and nuclear radiation—were moving ahead smoothly (although the USSR was still not taking part in the last-named). Despite delays that were mechanical and without political significance, observations were flowing freely into the three World Data Centers.

Perhaps the most extensive and successful of these cooperative efforts was in the Antarctic.

Antarctica

LLOYD BERKNER, WHO first proposed the IGY as another Polar Year, served as a radio engineer on Admiral Byrd's initial Antarctic expedition, and it is not surprising that the Antarctic was prominent even in the earliest IGY planning. One of the most immediate questions was who would go where. This was discussed at length at the 1954 CSAGI conference in Rome. At that meeting fourteen sites were recommended for new or reactivated scientific stations in Antarctica and its off-lying islands. In addition, virtually all existing stations maintained by Argentina, Australia, France, New Zealand, and the United Kingdom were to take part.

The most dramatic effort, as foreseen by the Rome conference, was to be the attempt to establish a United States outpost in the vicinity of the South Pole itself. No human being had set foot there except during the southern summer of 1911-12, when a team of five Norwegians, led by Amundsen, won the famous race to the bottom of the world. The losers, five gallant Englishmen, died en route back to McMurdo Sound.

Ten of the proposed new sites were tentatively allocated as follows:

Australia—Advanced Base (480 miles south of Mawson)
France—Pointe Géologie; Adélie Land (reactivated); Base Secondaire (near Magnetic Pole); Iles Crozet
Norway—Peter I Island; Bouvet Island
South Africa—Marion Island
United States—Little America; Marie Byrd Land; South Polar Plateau

Four sites were left open for any nation that wished to send an expedition: the Princess Astrid Coast, the Knox Coast, Ross Island, and Vahsel Bay. An array of scientific reasons was advanced as to why these places should be occu-

pied, such as their critical orientation with respect to study of the aurora and their need to complete the pole-to-pole chain of stations.

In one of the many conference resolutions CSAGI recommended "that as many nations as possible undertake geophysical observations in Antarctica during the International Geophysical Year." It also urged "that the various nations consider recommendations to establish stations at the gap-locations, as indicated in the resolutions of the CSAGI."[44]

The first IGY regional conference on the Antarctic, held in Paris from 6 to 10 July 1955, marked a turning point in the history of that continent, for it was then that Russia, which had not sent an exploratory expedition to Antarctica in over a century, entered the picture. At the opening session Colonel Georges Laclavère, Secretary-General of IUGG, who served as chairman of all the IGY Antarctic conferences, announced that Dr. Beloussov would attend. A subsequent telegram from Moscow indicated that a major Soviet expedition was planned. When Dr. Beloussov arrived at the conference at the start of its third day, he reported that the Academy of Sciences of the USSR was considering the establishment of three bases: one on the Knox Coast, one at the South Pole, and one roughly midway between those points. These stations, Dr. Beloussov noted, would complete the pole-to-pole station chain that bisected the Soviet Union.

With regard to the South Pole, the United States had already made considerable progress in its plans to place a station at that spot. The remaining two locations were within the vast sector of Antarctica claimed by Australia, and while the Australian delegates said nothing of the matter publicly, it was clear that they were disturbed at having Soviet bases established there—even scientific stations requested by IGY.

Furthermore, it became evident early in the conference that five nations were interested in the recommended site on the Knox Coast: Australia, Belgium, Japan, the Soviet Union, and the United States.

[44] CSAGI, *Bulletin d'Information*, No. 5, *op. cit.*, p. 61.

Another difficulty centered on the southeast corner of the Weddell Sea, where Argentina had just established a station partly for political reasons—to support the Argentine Antarctic claim over that of Britain. Sir David Brunt, vice-president of the Royal Society in London, said that Britain, unaware of the Argentine plan, had also decided to place a station there. The base was to serve two expeditions: one from the Royal Society, which would remain stationary and carry out IGY observations, and one that would attempt a transcontinental tractor journey under Dr. (now Sir) Vivian Fuchs. Argentina and Chile, on the one hand, and the United Kingdom, on the other, were most uneasy bedfellows in Antarctica. Their conflicting claims had led to various tense incidents, involving in one case sporadic machine-gun fire and in another two rival displays of naval power. The United States also was interested in a Weddell Sea station.

Colonel Laclavère ran the conference in a decidedly no-nonsense manner, and his forcefulness was unquestionably responsible for subduing the political controversies that repeatedly seemed about to erupt. There was some alarm among the scientists at the outset when they found that both the Argentine and Chilean delegations were headed by ambassadors rather than scientists. But in opening the first meeting Colonel Laclavère insisted that political questions had no place in the discussions and the two Ambassadors were willing to endorse his statement. They ultimately agreed to the principles underlying the allocations of sites—although it was evident that there would be a British IGY station at or near Vahsel Bay. However they stated for the record that "these are temporary measures" that "do not modify the existing status in the Antarctic regarding the relations of the participating countries."[45]

All of the station-allocation problems were resolved amicably at this and the next Antarctic conference, held in Brussels two months later. The Soviet Union accepted the conference recommendation that, instead of occupying the

[45] CSAGI, *Bulletin d'Information*, No. 7, *op. cit.*, p. 17.

South Pole, it set up its most remote station at the so-called Pole of Inaccessibility—the point in Antarctica farthest from the sea. It likewise agreed that its intermediate station be at the Geomagnetic Pole. As it turned out, none of the initial IGY bases was placed on the Knox Coast. The Russians went west of it, and the Americans went east. Australia, Belgium, and Japan headed for other parts of the coastline.

At the conclusion of the Paris conference, Dr. Beloussov raised two additional questions: mapping and the use of way stations in nearby countries by expeditions en route to and from Antarctica. With regard to mapping, Colonel Laclavère said he was in favor of an international effort, since he felt that adequate maps of the Antarctic continent were necessary to make sense out of the IGY results. But he proposed to postpone discussion of this question until the Brussels meeting. Meanwhile, he consulted with the Cartographic Section of the United Nations Department of Economic and Social Affairs which, he noted, was responsible for preparing an international map of the world on a scale of 1:1,000,000. The Soviet plan was for all expeditions in Antarctica to cooperate in preparing such a map of that continent, taking advantage of their aircraft to obtain photographic coverage. The Brussels conference decided that mapping was not eligible for inclusion in the IGY program, although the hope was expressed that any potentially relevant information gathered by the expeditions would be published.

The Operation Plan, drawn up by the United States Navy for its initial season of Antarctic operations in preparation for the IGY, called for an extensive program of aerial photomapping, using specially equipped aircraft with enough range to reach all parts of the continent from the proposed McMurdo Sound air strip. Permanent stations were also envisaged, "in support of United States 'rights' in the area."[46]

Although some aerial photography was carried out, the mapping plan was frowned upon by the scientists organizing

[46] Operation Deepfreeze (Operation Plan No. 1-55), Commander, U.S. Naval Support Force Antarctica, p. 2.

the United States IGY program on the grounds that it introduced a quasi-political element. The reference to United States "rights" was objected to strongly, and both elements were omitted from all subsequent operation plans. The Soviet expedition, on the other hand, went ahead with its mapping. The research ships Ob and Lena sent aircraft flying over the coast, photographing sections all the way from Queen Maud Land almost to the Ross Sea, embracing roughly half the continent and all of the Australian claim. Surveyors were landed by aircraft at a number of points to take celestial observations that would be used to orient the photographed features. The Russians continued to promote the idea of a joint mapping effort for the post-IGY period. This was discussed at the 1958 CSAGI conference in Moscow, but no final decision was made.

The question raised by Dr. Beloussov in Paris of using nearby nations as stepping stones into the Antarctic was acted upon at Brussels with a resolution that said, in part:

> The Antarctic Conference . . . RECOMMENDS to countries participating in Antarctic operations during the IGY that they give favourable consideration to requests for assistance in flying aircraft engaged in IGY activities, en route to Antarctica. In all cases negotiations must be made bilaterally.[47]

At that time the Soviet Union apparently expected to fly in large aircraft via Australia or South Africa, as the United States was to do from New Zealand. This, however, was never done. The United States used its largest operational transport planes—the Air Force C-124 Globemasters—to airlift about 600 tons of prefabricated buildings and other supplies that were dropped over the South Pole. The planes operated from a cleared strip of ice on McMurdo Sound—a runway subject to uneven melting in warm weather and also to sudden disappearance when summer storms blew the bay ice out to sea. The Soviet expedition used smaller planes, comparable in size to the Convair, that could be brought down by ship. It depended almost entirely on tractors for establishing its

[47] CSAGI, *Bulletin d'Information*, No. 7, *op. cit.*, p. 40. This issue contains accounts of the first two Antarctic conferences.

inland bases since, unlike the route from McMurdo to the Pole, there were no mountains straddling the way.

One decision of the Paris conference that imparted a friendly air to great-power relationships in the Antarctic was the formation of a Weather Central at Little America to analyze reports—from the other stations, from trail parties, aircraft, whaling fleets, and near-by countries—making possible for the first time a study of weather patterns at the bottom of the world and also providing much-needed forecasts for long aircraft flights. Furthermore the conference recommended that personnel of other participating nations serve tours of duty there. This led to an arrangement whereby a Soviet meteorologist was assigned to the Weather Central and a man from the United States Weather Bureau was stationed at Mirny, the chief Soviet base, which was set up near the Haswell Islets. Also at the Weather Central were meteorologists from Argentina, Australia, and France.

Nothing could have done more to allay fears and suspicions than this exchange. During the first year, the Soviet and United States meteorologists both got along well in their "ambassadorial" roles, as did their successors.

Nevertheless there was considerable alarm in Australia at the scope and seeming permanence of Soviet activities on a neighboring land mass. Few realized to what extent the Russians were carrying out the proposals of Western scientists. Thus, at the CSAGI Barcelona conference, a resolution was passed recommending that the Soviet program of ice studies be enlarged "by organizing glaciology groups on vessels travelling along the Antarctic coasts to reconnoiter certain parts of the Antarctic coasts from a glaciological and geomorphological point of view."[48]

If there was any doubt that the Soviet expedition would remain after the IGY, it was dispelled when the Special Committee on Antarctic Research (SCAR) was formed by ICSU in March 1957. The United States National Academy of Sciences felt that, after the huge expenditure of money, supplies, and effort (as well as loss of life) required to set up the

[48] Unpublished CSAGI material.

Antarctic stations, the added cost needed to run them another year or more would be well worth it. It was argued that the paucity of previous information from the Antarctic called for a longer observation period to establish the patterns of phenomena there.

Hence, at the fourth IGY Antarctic conference, held in Paris from 13 to 15 June 1957, the United States proposed a continuation of the work in the Antarctic after the IGY. Initial Commonwealth resistance, presumably a result of Australian misgivings, melted away after some further study by ICSU, and virtually all the nations active in Antarctica agreed to extend their programs for at least one more year.

Seven nations claimed pie slices of the Antarctic, all converging at the Pole. Those of Argentina, Chile, and the United Kingdom overlapped. The large sector embracing Marie Byrd Land had been unofficially claimed for the United States, which had not pursued the matter on the grounds that it was meaningless to claim such a region unless it was occupied. Hence the United States made no claims and recognized those of no one else. Yet many, if not all, of the European claimants, all of whom mutually recognized each other's claims, earnestly hoped that the United States would stick its powerful finger into the Antarctic pie. This would, in effect, underwrite their own claims. Perhaps what they most feared was Soviet entry into the area.

The IGY, in a sense, brought to pass both the hope and the fear. The result was a shift in the Commonwealth attitude toward an international arrangement for the Antarctic. One argument against such an arrangement had been that it might bring in the Russians. By 1958 it was obvious that they were not only in, but likely to stay.

An international solution had been discussed for a number of years. The United States had proposed it to the claimants in 1948, without favorable response. In 1956 an Indian proposal that the United Nations Assembly deal with it was shelved to avoid controversy during the IGY effort. In March 1957, when United States Secretary of State Dulles was in Australia for a SEATO meeting, the Australians pressed

upon him their disquietude at having Soviet bases so near by. A year later, in February 1958, British Prime Minister Harold Macmillan visited Australia and again the matter was discussed. Walter Nash, the Labour Prime Minister of New Zealand, had already made public statements in favor of an international solution, and at the conclusion of Mr. Macmillan's visit it was evident that the Commonwealth was prepared to back a plan in which control over Antarctica would be vested in a commission representing all the nations with interests there.[49]

On 2 May 1958, the United States transmitted a proposal to the eleven nations active in IGY work on or near the Antarctic. This included the seven claimants (Argentina, Australia, Chile, France, New Zealand, Norway, and United Kingdom) and four others (Belgium, Japan, the Soviet Union, and the Union of South Africa). It was proposed that these nations join in a treaty designed to preserve the continent as an international laboratory for scientific research and ensure that it be used "only for peaceful purposes." The treaty would provide that existing claims be unaffected by current and future research activities and that no new claims be made.

> In other words [the United States note said], the legal status quo in Antarctica would be frozen for the duration of the treaty, permitting cooperation in scientific and administrative matters to be carried out in a constructive manner without being hampered or affected in any way by political considerations.[50]

There could also be "such joint administrative arrangements as might be necessary and desirable to insure the successful accomplishment of the agreed objectives."

All eleven nations accepted the invitation to discuss such a treaty, but their notes of acceptance foreshadowed the difficulties that were to block further action, at least for the next seven months.[51] Moscow was clearly cool to any treaty

[49] *The New York Times*, 13 Feb. 1958.

[50] Text reproduced in *The New York Times*, 4 May 1958, p. 19.

[51] For an analysis, see the author's articles in *The New York Times*, 21 Aug. 1958, p. 2, and in *Foreign Affairs*, Vol. 36, No. 1 (Oct. 1957), pp. 154-66.

that preserved the legal status of other nations' claims but ruled out any Soviet claim.[52] Such was the temper of public opinion in Argentina and Chile that no government, it seemed, could accept any arrangement that smacked of international control.

The stated objective of the proposed treaty was to perpetuate the cooperation that had marked the IGY in Antarctica. This determination to continue the international program was shared by the scientists, but some of them, at least in the United States, were unhappy at the inauguration of what were bound to be political discussions. They felt that, in SCAR, a satisfactory working relationship had been established among the scientists of the nations concerned and that the entry of diplomats into the picture might lead to the same frustrations that had beset satellite-data negotiations.

Ironically, it was also argued that while a true settlement of the political problems of the area was, of course, desirable, it would probably lead to a curtailment of scientific work there by nations whose expeditions were strongly motivated by a desire to support their claims.

As 1958 drew to a close, the preliminary talks in Washington between the United States and the eleven nations to which it had sent its invitation seemed at a standstill. The scientific program in Antarctica, on the other hand, was in full swing. The IGY had produced a tacit agreement that there would be no public drum-beating and chest-pounding on the claims question. The political statements Moscow had been making on this subject since 1948 had come to a halt. It seemed possible, therefore, that even if there were no treaty, a continuation of scientific cooperation and coordination of activity in the Antarctic might gradually purge political rivalry from the world's seventh continent, providing a precedent for an international approach to the problems of outer space and the moon.

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[52] See letter of the Embassy of the USSR, Washington, of 2 June 1958. Translations from the Soviet Press, No. 329, Embassy of the USSR, Press Dept., 5 June 1958.

Legacy of the IGY

THE FINAL CSAGI meeting before the end of the IGY was held in Moscow from 30 July to 9 August 1958. Apart from the question of satellite data exchange, its chief task was to decide whether to extend the IGY or to depend upon newly created organs to continue international research in specific sciences. Two such units, including scientists from both the Soviet Union and the United States, had already been established in 1957: the Special Committee on Antarctic Research (SCAR), formed in the Netherlands in March, and the Special Committee on Oceanic Research (SCOR), which held its first meeting at Woods Hole, Massachusetts, from 28 to 30 August. There remained the question of forming a similar group on space exploration.

The Soviet delegation was strongly in favor of continuing the IGY, whereas scientists from the United States and other Western countries leaned rather to a less ambitious program built around such groups as SCOR and SCAR. The divergencies of view may have sprung from the fact that it was more difficult, in Moscow, to get a new policy decision than to get more money for research, whereas in Washington the reverse was true. The Soviet scientists in 1954 had "sold" the IGY to the Kremlin and the results had been gratifying, not only scientifically but personally. After years of comparative isolation, the Soviet scientists had regained contact with the Western world and found that their work was accepted and valued. Like their Western colleagues, they had also discovered that, at least in the world of science, peaceful coexistence and competition were practical realities. But, once the IGY policy decision had been made, it was easier to extend it than to obtain a decision on new proposals such as the creation of a special organ to coordinate space research.

The United States scientists, on the other hand, had obtained some $40,000,000 from Congress for what was to be a one-time expenditure. It was evident that far more than that had been spent in support from the Department of Defense, especially in the Antarctic (where aircraft losses alone ran into millions of dollars) and in the launching of earth satellites. Rather than ask for more money to extend the program, it might be more politic to ask for lesser sums for individual research projects.

In what was to some extent a compromise solution it was decided to end the IGY, but to have an "International Geophysical Cooperation 1959" which would carry on the work as far as possible on the same scale as during the IGY, but to a degree to be determined by each participant. It was also decided that after the demise of the IGY administrative structure "an appropriate international framework" should be established for "initiating and integrating collaborative research in the geophysical, astrophysical and allied sciences."[53]

Two political issues troubled the Moscow conference. One concerned the issuance of visas for participating scientists, in particular those from Nationalist China. The other involved censorship of news dispatches.

It was evident from the outset that it would be embarrassing for Moscow to admit Chinese Nationalists, whose participation in the IGY had led to withdrawal of the mainland Chinese. Washington had just thrashed out this problem—in reverse—with regard to a proposed symposium to be held in the United States to review IGY achievements after the Year was over. Such a meeting could bring to the United States delegations from North Korea, North Viet Nam, and Outer Mongolia—all IGY participants and all particularly distasteful, politically, to Washington.

State Department abhorrence of such a possibility had led to the withdrawal of a scheme to hold an earlier CSAGI meeting in the United States, but the fact that the Soviet

[53] Resolutions of the Fifth CSAGI Assembly, *op. cit.*, Doc. 159.

Union was now playing host to CSAGI presented the matter in a different light. If the Chinese Nationalists were admitted to Moscow, Washington could hardly ban the North Koreans. If the Russians barred the Nationalists, the United States, by boldly opening its doors to all, could make a favorable impression on scientists the world over. Hence it is understood that a week before the Moscow meeting the State Department notified the United States IGY leaders that an invitation to such a symposium would be in order.

By then it seemed likely that the Chinese Nationalists would not get to Moscow. Reportedly with encouragement from Washington, they had written to IGY headquarters in Brussels on 25 April, inquiring as to the procedure for attending the Moscow conference, and four days later they were sent conference accreditation forms provided by the Academy of Sciences in Moscow. These were mailed to Belgium on 9 May, reportedly with a request that the necessary visas be sent to the Nationalist Chinese Embassy in Paris.

But on 31 July, the day after the conference opened, the Nationalists sent the following message to Dr. Nicolet, by then in Moscow, and released it to the press:

> Please forward greetings from Chinese National IGY Committee to the Fifth Meeting CSAGI in Moscow, but we want put on record our disappointment over failure in processing necessary visa requirements for our delegates in time by Soviet government in contravention obligations of a host country according international practice.[54]

The United States delegation felt it had to demand an inquiry and a request for information was eventually sent by the CSAGI Bureau to Academician Bardin. Dr. Bardin later reported that no scientists from Taiwan had applied for visas in Paris and that no one who made proper application for a visa had been denied one. There was no firm evidence that the Nationalists' visa application forms had ever been submitted to the Soviet government. The Taiwan scientists had

[54] *The New York Times*, 1 Aug. 1958, p. 28.

been told by IGY headquarters to apply for their visas at a Soviet embassy, but this would have required them to embark on their journey before they knew whether they would be admitted. (The United States delegates felt that IGY headquarters should have been more forceful in aiding the Nationalists over this difficulty.) With only one exception,[55] all other visas seem to have been issued.

The Department of State in Washington, kept informed of developments via its Embassy in Moscow, pressed the delegation to demand a showdown at a plenary meeting, but although the United States scientists had at one point discussed a possible walkout or demand for a change of conference site, it was now impossible to accuse the Soviet Union of denying visas. Hence it was agreed that the whole question of political non-discrimination should be referred to the next ICSU General Assembly.

The censorship problem arose at the outset of the meeting, particularly with respect to a paper presented by Dr. Y. Kawabata, chief of the Division of Observations in the Japanese Meteorological Agency. He reported on a study of rain samples whose radioactivity, he said, originated in four areas: Eniwetok, Nevada, eastern and western Siberia, and the Arctic area north of Siberia. The first two were, of course, the United States test sites for nuclear weapons; the others were obviously Soviet test sites. He said that owing to prevailing winds the largest increases in radioactivity in Japan came from the Soviet sites.

Roughly half of a proposed Columbia Broadcasting System broadcast, including all reference to this paper, was deleted by the Soviet censor and similar stories by United States correspondents were held up. Several correspondents wrote letters of protest to Dr. Chapman, arguing, for example, that in censoring reports on papers presented the Soviet government, as host to the conference, was in effect censor-

[55] No visa was issued to an American gravimetrist, Dr. George P. Woollard, who had arranged to have it delivered to him at the Soviet Embassy in London. He suspected it was being withheld for political reasons and returned home before the matter could be taken up at the conference itself.

ing the scientific findings of the delegates.[56] When Dr. Odishaw brought up the Chinese question before the CSAGI Bureau, he also cited the reports of censorship. From then on the correspondents reported no further problems with the censors, and news stories that had been held up were released.

Continuation

The Moscow meeting of CSAGI was followed by a session of its parent body, the ICSU General Assembly, which met in Washington from 2 to 6 October 1958. This memorable session wound up the affairs of the IGY and charted future courses for international science. Largely because of the IGY, ICSU had emerged as the world's supreme nongovernmental organ in science. Among the actions of its General Assembly was the creation of a Special Committee for Inter-Union Cooperation in Geophysics (SCG) to take over some of CSAGI's functions when the latter organ dissolves 1 July 1959. Its primary task was to handle the closing stage of the IGY, including the International Geophysical Cooperation 1959, and to organize international "use and analysis of IGY data by World Data Centers, the International Unions, the World Meteorological Organization and otherwise."[57]

IGY programs in specific areas of science were also to be continued under the auspices of the various unions. An International Service for World Days was created, under URSI, to continue preparing yearly calendars of days for concentrated observation and to call "Alerts" and "Special Observational Intervals" when warranted by events on the sun.

In view of the difficulties over Nationalist China and censorship, a resolution on political non-discrimination was approved unanimously, stressing the "purely scientific character" of ICSU and stating, in part:

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[56] See *Science*, Vol. 128, No. 3333 (14 Nov. 1958), pp. 1197-8.

[57] Resolutions, Eighth General Assembly, ICSU. Resolution II published provisionally by the National Academy of Sciences, Washington (mimeo.).

Meetings or assemblies of ICSU or of its dependent organisms such as its special committees and its joint commissions should be held in countries which permit participation of the representatives of every national member of ICSU or of the dependent organisms of ICSU concerned, and allow free and prompt dissemination of information related to such meetings.[58]

This resolution cut two ways, since its sponsors had in mind not only the trouble in Moscow but also the question of holding such meetings in the United States. Although it previously had been agreed in Washington to invite CSAGI to hold the IGY post-mortem symposium in the United States, the question again seemed to be up in the air.

Perhaps the most historic action of the ICSU General Assembly was to create the Committee on Space Research (COSPAR), fruit of the resolutions on this subject passed at the rocket and satellite conference in Washington and at the CSAGI meeting in Moscow. It was originally envisaged that this would be a "special" committee, like SCAR and SCOR, but that word was dropped to win the support of some who did not, at the time, wish to create a permanent organ. The Committee was therefore given until the end of 1959

to provide the world scientific community with the means whereby it may exploit the possibilities of satellites and space probes of all kinds for scientific purposes, and exchange the resulting data on a cooperative basis.[59]

It was also to report to ICSU on means for bringing other nations into international space research. This was designed, for example, to enable scientists in smaller countries to prepare experiments to be carried out in the space vehicles of countries able to launch them. Likewise the group was to keep an eye on space control efforts in the United Nations:

The Committee shall hold as a primary objective the maximum development of space research programs by the international community of scientists working through the ICSU and its adhering national academies and unions. Recognizing, however,

[58] *Ibid.*, Res. XIII.
[59] *Ibid.*, Res. VI.

the need for international regulation and control of certain aspects of satellite and space probe programs, the Committee shall keep itself fully informed on United Nations or other international activities in this field, in order to assure that maximum advantage is accorded international space science research through such regulations, and to make recommendations relative to matters of planning and regulation that may effect the optimum program of scientific research.[60]

The Committee was to be composed of representatives from countries engaged in launching rockets and satellites (at the outset: Australia, Canada, France, Japan, the Soviet Union, United Kingdom, and United States), three from countries engaged in tracking space vehicles, chosen on a rotational basis, and representatives from the nine international scientific unions concerned with space research (IAU, IUGG, IUPAC, URSI, IUBS, IUTAM, IUPS, IUB, and IUPAP).

At its first meeting, in London on 14 and 15 November 1958, the Committee chose three representatives from the tracking countries: the Union of South Africa (three years). India (two years), and Peru (one year). The length of these terms, and the attendance at the organizational meeting of important space scientists from both the Soviet Union and the United States, suggested that the Committee was likely to become the permanent organ envisaged by ICSU.

Shortly after the London meeting, the United Nations General Assembly, by a vote of 53 to 9, with 19 abstentions, created a Committee on the Peaceful Uses of Outer Space,[61] although the Soviet Union announced it would not take part on the grounds that the composition of the committee was too pro-Western.

As the IGY drew to a close it was evident that its achievements had been historic, not only in science[62] but also in the relationship of man to man. It had contributed, in the words of CSAGI, "vast additions to knowledge and international

[60] *Ibid.*

[61] United Nations General Assembly Res. 1348 (XIII), 13 Dec. 1958.

[62] For a summary of IGY scientific achievements, see Walter Sullivan, *Natural History*, January 1959, pp. 10-21.

goodwill."[63] Its success, from the organizational point of view, was summarized by Lloyd Berkner to the Second United Nations International Conference on the Peaceful Uses of Atomic Energy, in Geneva. Because the actual work was directed and carried out by national committees rather than by an international body, he noted, the governments of the world responded favorably to requests for money and support.[64] The extent and cost of coordination on the international level was comparatively small. Likewise, the IGY had catalyzed much research that would never have been done and encouraged small countries to initiate what were likely to become permanent geophysical programs where hitherto there had been virtually none. It seems probable that as the world grows up economically, politically, and scientifically, there will be even more ambitious IGY's.

If considerable space has been devoted in this report to political difficulties of the IGY, it was in the belief that this might help to avoid them in the future. They did not dominate the IGY. Far from it, the general atmosphere was one of international cordiality and almost boundless enthusiasm. Nor can one separate the IGY from the growth of science's role in diplomacy during 1957 and 1958. Specialists from East and West in the United Nations Scientific Committee on the Effects of Atomic Radiation agreed that radioactive fallout was a hazard to future generations, their only point of difference being whether to recommend specifically an immediate cessation of nuclear test explosions. In Geneva another East-West conclave of scientists agreed, after long and secret discussion, on the feasibility of monitoring such explosions to support an agreement on their cessation. "Technical talks" seemed to have become an accepted approach to the long-stalled questions of a ban on nuclear explosions, protection against surprise attack, and, finally, disarmament itself.

In his Annual Report to the United Nations General Assembly, Secretary-General Dag Hammarskjold noted that

[63] Resolutions of the Fifth CSAGI Assembly, *op. cit.*, Doc. 159.
[64] Address of 12 Sept. 1958 (mimeo.), p. 13.

the Geneva agreement suggested a way "by which further progress might be made in separating the political from the non-political." Discussion by experts in science and technology

> would not in itself bring about disarmament, but it might help to improve the atmosphere and clarify many of the problems involved, thus preparing the ground for a time more politically propitious than the present seems to be for a general disarmament agreement.[65]

The IGY had helped significantly to contribute to the atmosphere of international scientific collaboration in which the Geneva talks were held. It had also pointed up the limitations imposed on such efforts by the dependence of scientists from the great powers on the support of their governments—and therefore on government approval of their actions in such controversial questions as earth satellites and China.

Thus an editorial in *Science,* organ of the American Association for the Advancement of Science, called for a combination of patience and toughness in dealing with the problem of Soviet satellite data. It cited the IGY's "remarkable record of data exchange," apart from the touchy area of satellite information, and said, "To the best of this country's knowledge, the Soviets have kept the formal agreements that they have made concerning the exchange of results in rocket and satellite research," but it added that Moscow had not been as free with its satellite data as the West would have liked. The feeling among United States scientists, it noted, was that "by and large the Soviet scientists are as anxious as we are to participate in the exchange of data," and that the flow in both directions was better than it had ever been. Nevertheless, it said, in view of the apparent restrictions imposed by the Soviet security system and other factors, the situation could not be improved by meekness. "It is difficult to see why," the editorial said, "without considerable prod-

[65] United Nations General Assembly, *Official Records*: 13th Sess., 1958, Suppl. No. 1A, p. 1.

ding, the Soviets will forego any arrangement that allows them to keep their cake and eat ours too."[66]

Undoubtedly contributing to Soviet suspicions was the fact that the Russians, due to their isolation in the preceding years, had played no role in initial IGY planning. The effort was led in large measure by men from the West. Nevertheless the scientists on both sides seemed anxious to avoid airing their differences publicly. There appeared to be genuine efforts at compromise, and as an experiment in scientific cooperation across all political boundaries the Year was highly successful. At the many IGY conferences one felt that all participants, regardless of political background, were determined to make the Year a success and to forge from it a model for broader cooperative efforts in the future.

[66] Joseph Turner, in *Science*, Vol. 128, No. 3334 (21 Nov. 1958), p. 1249.

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